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USSR Report

CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

(FOUO 24/81)

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CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

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CONTENTS

HARDWARE

ARCHITECTURE OF COMPUTING SYSTEMS WITH PROGRAMMED STRUCTURE

Novosibirsk ARKHITEKTURA VYCHISLITEL'NYKH SISTEM S PROGRAMMIRUYEMOY STRUKTUROY: VYCHISLITEL'NYYE SISTEMY in Russian No 82, 1980 (signed to press 2 Dec 80) pp 2, 110-112

[Annotation and abstracts of articles from book "Architecture of Computing Systems With Programmed Structure"; editorial board: V. L. Lyatlov, E. V. Yevreinov, Yu. S. Zab'yakov, N. G. Zagoruyko, Yu. G. Kosarev (editor-in-chief), V. A. Skorobogatov, and V. G. Khoroshevskiy, USSR Academy of Sciences, Siberian Department, Institute of Mathematics, 800 copies, 112 pages]

[Text] The results of investigations of architectural features of computing systems with a programmed structure are published in the book. A method of distributing tasks in the system and a method of addressing machines are proposed which assure effective accomplishment of computations. Methods are developed for parallel microprogramming: the property of non-contradiction of parallel microprograms was investigated, the language of simulation of parallel microprogram structures and a method of converting Petri networks are described which reduce the complexity of analysis of parallel microprograms for correctness. Some results are presented on developments of software of systems of mini- and micro-computers and a programming system for logical and structural simulation.

The materials of the collection can be useful to specialists in the area of computer technology, scientific workers and graduate students in the specialty of computers and systems.

UDC 681.322.06:681.3.323

ON DECENTRALIZED DISTRIBUTION OF TASKS IN UNIFORM COMPUTING SYSTEMS WITH PROGRAMMED STRUCTURE

[Abstract of article by Kerneyev, V. V., and Monakhov, O. G.]

[Text] A method is proposed for the separation of connected subsystems intended for the solution of parallel tasks, each of which requires for its accomplishment subsystems with a set number of machines. The method does not require knowledge of complete information on the state of the computing system and tasks entering the system. A method is presented for addressing machines of a subsystem, a method which assures effective realization of interactions between machines.

UDC 681.325.5

RECOGNITION OF THE CONSISTENCY OF STATIONARY SUBSTITUTION ALGORITHMS

[Abstract of article by Sergeyev, S. N.]

[Text] The article examines questions regarding recognition of the consistency of parallel substitution algorithms. For a subclass of the class of stationary substitution algorithms--Neumann algorithms--necessary and sufficient conditions of consistency are formulated. The condition of reducibility of a stationary to a Neumann algorithm is formulated. The class of consistent algorithms is investigated and it is shown that it is enclosed in the class of stationary algorithms.

UDC 681.325.5

LANGUAGE FOR MICROPROGRAMMED DESCRIPTION OF UNIFORM PARALLEL COMPUTER MODELS

[Abstract of article by Piskunov, S. V.]

[Text] A description is presented of the principal constructions of a language based on concepts of parallel microprogramming and parallel substitution algorithms. The language is intended for microprogrammed description of uniform parallel computer models. It reflects the localness of cell interactions and the parallelism of data processing in equipment. Application of the language for construction of a microprogrammed model of a computer with a uniform structure is demonstrated.

UDC 681.322.01

PETRI NETWORK REDUCTION

[Abstract of article by Anishev, P. A.]

[Text] A set of conversions (reduction rules) of Petri networks is proposed. Those conversions permit curtailing the initial network while preserving the properties of animation and safety. An algorithm for network reduction is discussed from the point of view of the sequence in the application of rules, their complexity, independence, etc. Some general questions of network reducibility are discussed.

UDC 661.32.324

INVESTIGATION OF A MULTIMACHINE MINIMAX SYSTEM FOR DEBUGGING OF PARALLEL PROGRAMS

[Abstract of article by Kolosova, Ye. I.]

[Text] The author examines the main distinctive features of the functioning of a two-machine debugging program intended for complex debugging and check routine tesing of parallel programs in a given configuration of a uniform computing system.

UDC 681.3.06

PRINCIPLES OF CONSTRUCTION OF A SOFTWARE SYSTEM OF PARALLEL COMPUTING STRUCTURES BASED ON SPECIALIZED MICROPROCESSORS

[Abstract of article by Guzik, V. F., and Piterskiy, A. I.]

[Text] A new approach is proposed for construction of software for parallel digital integrating structures (using specialized microprocessors) based on use of a high-level language for description of software and hardware and the method of cross-development using a universal computer.

UDC 681.142.2:681.31

THE R-LYAPAS-BESM-6 PROGRAMMING SYSTEM. REALIZATION OF THE FIRST LINE

[Abstract of article by Vorob'yev, V. A., Goralik, V. M., and Monakhova, E. A.]

[Text] The article describes the structure of the R-LYAPAS-BESM-6 programming system, intended for description and realization of a program system with a total volume of about 120,000 instructions written on the macrolevel, basic and systems level of the R-LYAPAS instrumental language. A formal static model of the product of the system is given and the functions of all system units are described. The system is constructed by the method of dynamic unwinding and allows the possibility of further accumulation.

UDC 62-507

LOGICAL METHODS IN MACHINE VISION

[Abstract of article by Levin, V. I., and Perel'royzen, Ye. Z.]

[Text] Logical methods of analysis of a three-dimensional environment are described which represent a special sorting procedure. Used as mathematical apparatus are infinite-valued logic and the theory of logical determinants.

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CSO: 1863/265

MEETING OF USSR NATIONAL COMMITTEE OF INTERNATIONAL ASSOCIATION ON MATHEMATICAL AND COMPUTER MODELLING IMACS (AICA)

Kiev ELEKTRONNOYE MODELIROVANIYE in Russian No 3, May-Jun 81 (signed to press 24 Apr 81) pp 106-107

[Excerpts from article by Ts. S. Khatiashvili and A. Ye. Stepanov]

[Excerpts] A meeting of the USSR National Committee of the International Association on Mathematical and Computer Modelling IMACS (AICA) in which specialists of different organizations of Tbilisi, Moscow, Leningrad, Kiev, Odessa, Tashkent, Kishinev, Riga, Kuybyshev and other cities of the Soviet Union participated, was held on 26-29 October 1980 in Tbilisi at the Tbilisi Scientific Production Association Elva.

Academician of the Georgian SSR Academy of Sciences I. V. Prangishvili, in his report "Highly Productive Multiprocessor Problem-Oriented Computer Complexes for Geophysical Problems," presented two models of highly productive multiprocessor computer complexes with rearranged structure for expeditionary and regional geophysical computer complexes. One model, containing up to 64 processors and providing a speed of up to 100 million operations per second, is related to configuration of machines with many data flows and a single instruction flow for operating in the single-problem mode with regular problem algorithms having natural parallellism. Another model that provides speed up to several tens of millions of operations per second is related to a configuration with many data and instruction flows and operates effectively in single- and multi-task modes with less regular problem algorithms subject to parallelling.

The high productivity and survivability of the developed multimicroprocessor computer systems provided as a result of dynamic rearrangement of the system structure according to the requirements of the computing process, parallelling of the calculation process at the level of problems, branches of vector and scalar operations and instructions accomplished without access to an operating system, were noted.

6521
CSO: 1863/249

UDC 519.59

SELECTION OF MILITARY COMPUTER ARCHITECTURE

Moscow ZARUBEZHNAYA RADIOELEKTRONIKA in Russian No 8, Aug 81 pp 24-45

[Article by V. A. Vedeshenkov, N. A. Vlasenko, and A. M. Shevchenko, candidates of technical sciences]

[Excerpt] 6. Final Recommendations on Computer Family Architecture Selection

The conducted analysis made it clear that the strong and weak aspects of the three most completely evaluated computing system architectures are the following [1, 11].

Interdata 8/32. The architecture of this computing system has the highest total evaluation for quantitative criteria and gives better results during the running of test programs. It has good organization of the interruption system, which assures its efficiency in real time. However, the software of this computing system is very poor, and this has a direct effect on the cost of its life cycle. There also are certain doubts about the efficiency of organization in this computing system of protection of the state of the machine during processing of interruptions by the processor.

IBM S/370. The main merit of this computing system is its powerful software, as a result of which its architecture has a good indicator of cost of the life cycle, especially when the cost of program development is high. On the other hand, the interruption system adopted in this computing system makes it difficult to use in real-time systems. The running of test programs has also shown that the efficiency of its architecture is lower than that of the Interdata 8/32 and PDP-11 computing system architectures. The investigations have made it clear that the junior models of that family do not assure sufficiently high indicators during their use in control systems presenting low requirements for the computing system parameters.

PDP-11. The 70th model of this family was examined. This computing system has fairly complete software and also shows high characteristics during the running of test programs. Because of good organization of the interruption system it is well suited for work in real time. The PDP-11 has definite advantages over other considered computing systems as regards cost of the life cycle. To the merits of this computing system one can also add the fact that its microprocessor realization practically exists. A negative aspect of this computing system is a virtual address space limited to 16 bits.

As a result of the work done the commitee for selection of CFA architecture prepared the following recommendations:

1. It was acknowledged that the PDP-11 computing system is the most suitable for construction of a military computer family (MCF). The IBM S/370 was ranked second, and the Interdata 8/32 third.

2. The committee concluded unanimously that a single instruction system and a single architecture must be adopted for the entire military computer family. The recommendation that one of the three investigated architectures be used is an alternative.

3. The committee considers it necessary to moderate the individual limitations on selection of the computer family architecture (CFA). Among such limitations, in particular, is the digit capacity of the virtual address space, which restrains selection of the PDP-11 architecture as the CFA.

The adknowledged winner, the PDP-11 computing system, has the best architecture in the sense of its application in practice among all the computing systems created up to now. It is produced in tens of thousands and used in quite varied applications. It has powerful software, which also continues to be developed at the present time. For purposes of the conducted investigation it was not important that the DEC Company had not been designated to produce a military version of the PDP-11 family. The purpose of the project was to determine the computing system architecture with which various producers (not necessarily producers of the commercial variant of the system) would be able to develop computing systems satisfying with their parameters the military requirements.

In accordance with the recommendations the Norden Division of United Technologies has acquired from the DEC Company a license for the production of a military version of the PDP-11 family [8, 19]. That compnay has been designated to produce military analogs of all models of the PDP-11 family--from the LSI-11 microcomputer to the large PDP-11/70 computer. The military version of the PDP-11 family has been given the name AN/UYK-41. It is assumed that small, medium and large computing systems of this family, corresponding to models LSI-11, PDP-11/34 and PDP-11/70 of the PDP-11 family, will a very large distribution in tactical data processing systems. The operating conditions of all Norden computing systems satisfy the corresponding requirements of the military standards and have smaller dimensions and smaller mass than similar commercial models of the DEC Company. Thus, the computing system AN/UYK-41/34M occupies about one fourth the volume of the PDP-11/34 computing system, and weighs about one third as much. As a result of a more complex technology of production the AN/UYK-41 computing system is much cheaper than the corresponding models of the PDP-11 family.

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2174
CSO: 1863/262

UDC 381.325

MULTIPROCESSOR COMPUTER SYSTEMS WITH COMMON INSTRUCTION FLOW

Moscow MNOGOPROTSESSORNYYE VYCHISLITEL'NYYE SISTEMY S OBSHCHIM POTOKOM KOMAND in Russian No 19, 1978 pp 2-4, 106-107

[Annotation, table of contents, foreword and abstracts from the collection: "Multiprocessor Computer Systems with Common Instruction Flow", Ordena Lenina Institut problem upravleniya, 500 copies]

[Text] The structures, sets of instructions and methods of realizing multiprocessor computer systems with common instruction flow and problems of modelling asynchronous processes are considered. Methods are suggested for making calculations in parallel and the characteristic features of optimizing the algorithms in the systems under consideration are investigated.

Contents

Foreword

The attitude of users toward multiprocessor computer systems (MVS) with common instruction flow fluctuates from approval of these systems as the only possible version of the digital computer of the future to complete rejection of their effectiveness. Essentially, systems of this type are problem-oriented. Therefore, their use in the corresponding fields may actually yield unusually high effectiveness. On the other hand, atempts to use multiprocessor computer systems in fields and modes not inherent to them do not yield the proper effect.

Multiprocessor computer systems with common information flow are effective for problems whose resolving algorithms first met sufficiently good parallelling and second require either high speed or low cost-productivity ratio.

The range of problems encompassed by the conjunction of these two requirements is rather broad. They include problems of random process filtration, pattern recognition, solution of equations in partial derivatives, modelling of dynamic objects and many others, i.e., problems of processing the results of geophysical investigations, information from satellites, design and so on.

The proposed collection is devoted to the most important aspects of development and application of multiprocessor computer systems. Problems concerning both the principles of multiprocessor computer system design, sets of instructions and control systems and organization of the computing process, including making calculations in parallel and organization of algorithms that minimize problem-solving time. Since the same problem can be solved by several methods, a number of articles is devoted to selection of algorithms that permit broad parallelling and to organization of the sequence of calculations if broad parallelling is impossible.

Problems of developing complexes that include control computer systems as the central computer are considered in four articles.

As a whole, the collection will be useful to both engineers working in fields of multiprocessor computer system design and application and to students and graduate students studying specific problems of modern electronic machine building.

UDC 681.325

PRINCIPLES OF DESIGNING MULTIPROCESSOR COMPUTER SYSTEMS WITH COMMON INSTRUCTION FLOW

[Abstract of article by Medvedev, I. L.]

[Text] The principles of design and organization of control of multiprocessor computer systems with common instruction flow, intended for solving problems having various types of parallellism, are considered. The effectiveness of these systems for different applications are analyzed.

UDC 681.326.3

SELECTING THE SET OF INSTRUCTIONS FOR A MULTIPROCESSOR COMPUTER SYSTEM WITH COMMON INSTRUCTION FLOW

[Abstract of article by Fishchenko, Ye. A.]

[Text] The requirements on the set of instructions for a multiprocessor computer system with common instruction flow are formulated. Sets of instructions for multiprocessor computer systems oriented toward solving problems with various types of parallellism are described.

UDC 681.3.2

RESOLVING FIELDS OF MULTIPROCESSOR COMPUTER SYSTEMS

[Abstract of article by Biryukov, A. Ya., Golovan, N. I., Medvedev, I. L., Nabatov, A.S. and Fishchenko, Ye. A.]

[Text] The characteristic features of the structure of the resolving field, ensuing from the concept of a highly productive computer system with common instruction flow that utilizes the structural programming method, are considered. Examples of resolving fields of two systems oriented toward solution of different classes of problems--primarily with logic or arithmetic data processing--are discussed.

UDC 681.326

LOCAL MANAGEMENT IN MULTIPROCESSOR COMPUTER SYSTEM WITH COMMON INSTRUCTION FLOW

[Abstract of article by Biryukov, A. Ya.]

[Text] Problems of using local management to increase flexibility, to expand the classes of effectively resolved problems, to simplify central management and to organize asynchronous processes in multiprocessor computer systems with common instruction flow are considered. The principles of designing local management devices are outlined and examples of their application are discussed.

UDC 681.326

METHOD OF MAKING GROUP CALCULATIONS IN PARALLEL IN MULTIPROCESSOR COMPUTER SYSTEM WITH COMMON INSTRUCTION FLOW

[Abstract of article by Zatuliveter, Yu. S.]

[Text] A method is proposed for making group calculations in parallel based on the asynchronism of making the calculation and realizing these calculations in a multiprocessor computer system with common instruction flow. It is shown that a uniformly high processor load is provided for large-dimension problems.

UDC 681.3.06:51

ORGANIZING THE CALCULATING PROCESS IN A MULTIPROCESSOR COMPUTER COMPLEX

[Abstract of article by Rozenblit, S. I.]

[Text] A method is proposed for dynamic organization of the calculating process in a multiprocessor computer complex based on the use of a hierarchical N-graph and its matrix of states.

UDC 681.3.057

SLIDING METHOD OF SOLVING ORDINARY DIFFERENTIAL EQUATIONS IN A MULTIPROCESSOR COMPUTER SYSTEM WITH COMMON INSTRUCTION FLOW

[Abstract of article by Vilenkin, S. Ya., and Komarovskiy, A. A.]

[Text] A parallel sliding algorithm for solving the ordinary differential equation $y^{(1)} = f(x, y)$ with the initial condition $y(x_0) = y_0$ is considered.

UDC 681.3.06

CALCULATION OF ARITHMETIC EXPRESSIONS IN A MULTIPROCESSOR COMPUTER SYSTEM WITH COMMON INSTRUCTION FLOW

[Abstract of article by Uvarov, S. I.]

[Text] The problem of compiling optimum schedules for calculation of arithmetic expressions in a multiprocessor computer system is considered on the assumption that all processors can perform the same operation simultaneously. A schedule compilation algorithm for two processors and the expressions that contain addition and multiplication operators are presented and investigated.

UDC 681.3.06

APPLYING THE DYNAMIC PROGRAMMING METHOD TO OPTIMIZATION OF STATISTICAL DATA PROCESSING PROBLEMS IN MULTIPROCESSOR COMPUTER SYSTEMS

[Abstract of article by Grishina, I. M.]

[Text] A method of selecting the time-optimum realization of an algorithm of given structure in multiprocessor computer systems with common instruction flow, based on the dynamic programming principle, is considered.

UDC 681.327

PROBABILITY MODEL OF A MULTIPROCESSOR COMPUTER COMPLEX

[Abstract of article by Fedotov, A. G.]

[Text] A two-phase model of a computer complex with arbitrary number of devices in both phases and with a buffer of arbitrary length between phases and interlocking of the first phase for filling the buffer is considered. A solution is found for the problem and the mean values and standard deviation of the length of the line in both phases of the system and also the maximum capacity of the system are determined.

UDC 681.327

ITERATIVE CALCULATION OF SOME PARAMETERS OF A MULTIPHASE QUEUEING SYSTEM WITH INTERLOCKS

[Abstract of article by Yermakov, A. S.]

[Text] An iterative algorithm is presented for calculating the probability of interlocking of individual phases of an open multiphase queueing system with more than two phases. The results of calculation are compared to the results of iterative modelling.

UDC 681.327

SELECTION OF BUFFERS FOR THE STOCHASTIC MODEL OF A MULTIPROCESSOR COMPUTER SYSTEM WITH COMMON INSTRUCTION FLOW

[Abstract of article by Yermakov, A. S. and Nabatov, A. S.]

[Text] The order of solving the problems for determining the lengths of the buffer exchange zones is presented for a stochastic model of a multiprocessor computer system under development. The problem is solved by means of the iterative method. The results of iterative calculation are compared to the precise solution for a special case.

6521
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UDC 681.142

ABSTRACTS FROM THE COLLECTION 'HYBRID COMPUTERS AND COMPLEXES'

Kiev GIBRIDNYYE VYCHISLITEL'NYYE MASHINY I KOMPLEKSY, VYPUSK 3: KONTROL' I DIAGNOSTIKA VYCHISLITEL'NYKH I UPRAVLYAYUSHCHIKH SISTEM in Russian No 3, 1980 (signed to press 25 Nov 80) pp 111-114

[Abstracts from the collection: "Hybrid Computers and Complexes, No 3, Control and Diagnosis of Computer and Control Systems", Institute of Electrodynamics, Electronics and Modelling Sector, Ukrainian SSR Academy of Sciences, 1,000 copies, 114 pages]

UDC 681.142

COMPILING FUNCTIONAL TESTS FOR MICRORPRCESSORS

[Abstract of article by Gulyayev, V. A.]

[Text] Problems of formalized compilation of tests for microprocessors are considered. A method is proposed for preparing functional tests, including compilation of test microprograms and selection of operands and addresses.

UDC 65.011.56:681.3.06

SOFTWARE FOR AN AUTOMATED MONITORING DESIGN SYSTEM

[Abstract of article by Shcherbinin, Yu. G.]

[Text] The software structure of an automated design and programming system of automated monitoring and control systems ASPP ASKU is considered. Main attention is devoted to means of describing the data in the system and to means of design and programming automation. The order of program operation in the system and the main characteristics of the programs are shown.

UDC 621.317.7

UNIVERSAL INPUT UNIT FOR A MULTICHANNEL INFORMATION-MEASURING SYSTEM

[Abstract of article by Khoroshko, V. A.]

[Text] The input unit of a multichannel information-measuring system is considered which permits one to use various types of sensors and to carry out preliminary processing and signal linearization and normalization. The configuration of the unit is based on the use of a parallel-series structure with multilevel commutation.

UDC 681.142

SELECTING A CONTROL COMPLEX MONITORING SYSTEM

[Abstract of article by Burov, V. A., Sorochinskaya, O. A. and Chichikanov, I. V.]

[Text] The effectiveness of introducing a hardware and software monitoring system for a control computer complex is considered.

UDC 681.142

ANALYSIS OF SEQUENTIAL CIRCUITS IN DEDUCTIVE MODELLING OF MALFUNCTIONS

[Abstract of article by Zakhar'yevich, I. A. and Chaprak, L. I.]

[Text] Problems of increasing the effectiveness of deductive modelling of logic circuits with malfunctions are considered. An algorithm is presented for preliminary analysis of series circuits that permits one to reduce the storage capacity required to store lists of malfunctions and to simplify operations on the lists.

UDC 681.142

APPLICATION OF LOGIC CIRCUIT MODELLING IN STATISTICAL MONITORING METHODS

[Abstract of article by Pleshkanovskaya, O. M. and Chaprak, L. I.]

[Text] The possibility of using logic modelling in statistical methods of monitoring the circuits of digital devices is considered.

UDC 681.325.6.001.4

MATHEMATICAL MODELLING OF COMBINATION CIRCUITS WITH REGARD TO POSSIBLE MALFUNCTIONS

[Abstract of article by Krasnov, V. V. and Krulikovskiy, B. B.]

[Text] Problems of minimizing the generalized logic models of logic components are considered. Algorithms are proposed for formation of optimum models of combination circuits.

UDC 681.326

CHECKING A PARALLEL BINARY CODE FOR EVENNESS

[Abstract of article by Rybakov, S. V.]

[Text] Known series and parallel methods of realizing devices for checking a binary code for evenness are considered. A series-parallel method of realization is

suggested that permits one to change the speed and amount of equipment of the checking device within permissible limits, thus adapting it to the given requirements. An example of realizing the proposed method is presented. The speed and amount of equipment of the checking devices realized by parallel, series and series-parallel methods are compared.

UDC 681.326.74

FINDING THE SHORTEST DISTINGUISHABLE SEQUENCE FOR A FINITE AUTOMATON

[Abstract of article by Belichenko, T. P., Belov, G. I. and Derbunovich, L. V.]

[Text] An algorithm and program are described for finding the shortest distinguishable sequence for a finite automaton. It is suggested that simple σ-sets be excluded from A-groups and that the input data be represented in the form of files to reduce the number of sampling operations and the required computer storage capacity.

UDC 62-50

METHOD OF CLEAR IDENTIFICATION OF AN AUTOMATON BY DETERMINING THE NUMBER OF TRANSITION TRACKS

[Abstract of article by Myz', A. N. and Liberg, I. G.]

[Text] A formal method of clear identification of a sequential automaton by determining the minimum number of transition tracks used to form test sequences in the case of masking of the output realization of the automaton, which is a composition component and other components of this composition, is considered.

UDC 381.326.7

USING BOOLEAN DIFFERENCES TO SYNTHESIZE TESTS OF CIRCUITS WITH PSEUDO-PRIMARY INPUTS

[Abstract of article by Frolova, I. Ye.]

[Text] A modification of an algorithm for synthesis of tests by the Boolean difference method is suggested for covering all malfunctions upon branching of primary inputs of circuits with branching coefficient $p_i > 1$. Analysis of the structural redundancy of a logic circuit with pseudo-primary inputs is presented.

UDC 681.31

DETERMINATION OF MALFUNCTIONS IN A SYSTEM FROM THE RESULTS OF CHECKING THE PARAMETERS

[Abstract of article by Dotsenko, B. I.]

[Text] Diagnosis of a system from the results of analyzing the measured parameters is considered. A differential equation is presented for determining the weight function of the parameter measuring device. An algorithm for determining the malfunction in the system is found from the condition of minimum average risk.

UDC 621.317

EFFECTIVENESS OF SOME EFFICIENCY CHECKING ALGORITHMS

[Abstract of article by Belokon', R. N., Kendel', V. G. and Kuznetsov, A. M.]

[Text] Three efficiency checking algorithms--optimum, majority and sequential majority--are considered and investigated. The checking algorithms are compared by reliability, average risk and hardware realization. The advantages of a sequential majority efficiency checking algorithm are shown.

UDC 621.396.66

ANALYZING THE RELIABILITY OF RESULTS FROM QUANTITATIVE CHECKING OF THE EFFICIENCY OF ARTICLES

[Abstract of article by Belokon', R. N.]

[Text] The problem of determining the reliability of results of quantitative checking of the efficiency of articles D is considered. Analytical expressions are suggested for calculation of indices D. The relationship between indices of the reliability of quantitative and qualitative control is shown.

UDC 62-50

DETERMINING THE PERIOD OF CHECKING THE PARAMETERS OF A MONITORING AND CONTROL FACILITY

[Abstract of article by Ivanov, V. M.]

[Text] The problem of determining the period for checking parameters during tolerance monitoring is considered. The derived processes are introduced by using nonlinear transformation of the initial process when fixing the tolerances. The problem of determining the checking period is solved as one of time quantification of the derived processes. The properties of one- and two-dimensional and probability densities and correlation functions of derived processes are used.

UDC 681.32.019.3

ANALYZING ALGORITHMIC METHODS OF INCREASING THE NOISE STABILITY OF LOGIC CONTROL DEVICES

[Abstract of article by Koloskov, V. A., Koloskova, G. P. and Tipikin, A. P.]

[Text] Algorithmic methods for increasing the noise stability of control devices are considered. A method is proposed for analyzing the probability of correct solution of the control problem with regard to the self-correcting capability of the input algorithms. The dependence of the probability of correct solution of the problem by transformed algorithms on self-correcting capability, the detecting capability of checking and the reliability of the units of the device is found. The effectiveness of the method of increasing noise stability, based on joint use of periodic and forced returns, is shown.

UDC 62-50

USE OF ODD SETS FOR DIAGNOSIS OF COMPLEX SYSTEMS

[Abstract of article by Vakhid, A., Voronov, V. G., Derbunovich, L. V. and Kordyumov, A. I.]

[Text] The use of odd sets in diagnosis of complex systems is described for which precise mathematical methods are unacceptable due to the large volumes of calculations. Diagnosis of a system consisting of m units whose aggregate syndrome is described by the state of diagnostic signals of each unit, is considered.

UDC 681.327:681.326.74.06

ALGORITHMIC METHOD OF CHECKING SEMICONDUCTOR STORAGE DEVICES

[Abstract of article by Belov, G. I.]

[Text] A method is described for checking constant malfunctions in semiconductor storage devices with arbitrary access. It is shown that the considered method is easily realizable by hardware.

UDC 518.12

ADAPTIVE ALGORITHMS FOR CHECKING THE NUMERICAL SOLUTION OF EQUATIONS OF DYNAMICS

[Abstract of article by Latyshev, A. V.]

[Text] Algorithmic checking of breakdowns at each step of real-time numerical solution of equations of dynamics is considered. Adaptive versions of checking algorithms based on extrapolation and interpolation of the process being monitored are proposed.

UDC 62-50:519.14

AUTOMATIC DESIGN OF A TOPOLOGICAL MODEL OF A COMPLEX SYSTEM FOR SOLUTION OF PROBLEMS OF DIAGNOSTICS

[Abstract of article by Grundspen'kis, Ya. A. and Tenteris, Ya. K.]

[Text] Computer design of a topological model of a complex system in the form of an organizational flow chart is considered for solving problems of diagnosis of complex analog systems. A method of forming a set of functional phrases from a meaningful description of the system, on the basis of which the procedure for formation of the arc between two vertices is developed and an algorithm for design of a topological model realized in the form of a program written in PL/1 language, is proposed. The main principles of operation of the algorithm in two modes are outlined.

UDC 621.3.019.3

MATHEMATICAL MODEL OF THE RELIABILITY OF A WEAK-CURRENT SLIDING CONTACT

[Abstract of article by Strel'nikov, V. P., Pranik, B. V. and Kostra, M. G.]

[Text] A mathematical model of the reliability of sliding electrical contacts, designed on the basis of analyzing the dynamics of the process of variation of contact resistance, is considered. Variation of the dynamic contact resistance is approximated by a diffusion Markov process. An experimental-statistical check showed that the proposed model does not contradict experimental data and has more effective approximating qualities upon equalization of the statistics of sliding contact failure compared to other distributions (exponential, Weibull and normal).

UDC 62-501.14

ALGORITHM FOR DETERMINING THE TOLERANCES OF THE PARAMETERS OF INFORMATION DEVICES

[Abstract of article by Pampuro, V. I. and Novitskiy, V. V.]

[Text] The solution of a problem and an algorithm for determination of the tolerances of the determined rational function of the output parameter with incomplete statistical data on independent variables is outlined. An example of computer solution is presented. Some theorems that determine the point of the highest (lowest) value of the function of many variables are proved in the appendix, which permits one to exclude selection of all its boundary values.

UDC 62-50:621.311.22

PREDICTING THE VARIATION OF THE PARAMETERS OF THERMAL MONITORING AND CONTROL EFFECTS OF THE STEAM GENERATORS OF ENERGY UNITS

[Abstract of article by Ivanov, V. M.]

[Text] The problem of predicting the variation of parameters and the control effects of a complex object is considered for use in real time by means of control computer complexes. Methods of identification and self-adjusting systems are used as the basis. The parameters of the model and facility are adjusted by the compensation scheme with a parallel local model.

6521
CSO: 1863/243

SOFTWARE

PARALLEL MICROPROGRAMMING METHODS

Novosibirsk METODY PARALLEL'NOGO MIKROPROGRAMMIROVANIYA in Russian 1981 (signed to press 13 Feb 81) pp 2-4, 179-180

[Annotation, foreword and table of contents from the book "Parallel Microprogramming Methods", by Petr Aleksandrovich Anishev, Svetlana Mikhaylovna Achasova, Ol'ga Leonidovna Bandman, Sergey Vladislavovich Piskunov and Stanislav Nikolayevich Sergeyev, Izdatel'stvo "Nauka", 4,600 copies, 181 pages]

[Text] The book is devoted to theoretical problems of parallel microprogramming and methods of designing microprogram computer systems and parallel information processing structures. Parallel microprogramming is considered as a combination of algorithmic means of describing parallel calculations with the principles of modern microprogramming. Methods of representing parallel microprogram algorithms and methods of interpreting them by automaton networks and homogeneous machines are outlined in detail. The possibilities of using the considered methods to design parallel information processing devices based on a modern component base (microprocessor sets, programmable logic matrices and so on) are shown and practical algorithms for design of microprogram control are also presented.

The book is intended for scientific workers, graduate students and students specializing in the field of computer technology and engineering cybernetics and also for developers of computers.

Foreword

The results of research conducted at the Institute of Mathematics, Siberian Department, USSR Academy of Sciences, in the field of developing the microstructure of parallel processing computers are outlined in the book. The investigations were begun in the mid-1960's under the supervision of E. V. Yevreinov, who determined the directions of research and developed the basic theoretical propositions.* During those years microelectronics was seemingly being developed at such rates that production of homogeneous structures consisting of millions of switching and storage devices in a single production cycle which could then be converted through programming to specialized parallel processing computers, would become a reality

* E. V. Yevreinov and Yu. G. Kosarev, "Odnorodnyye vychislitel'nyye sistemy vysokoy proizvoditel'nosti" [Highly Productive Homogeneous Computer Systems], Movosibirsk, Nauka, 1966.

within several years. These structures were called computer media since they were regarded as spaces filled with physical objects whose functional properties could be varied externally.

The search for ways to develop computers based on computer media was conducted in all directions. The technological possibilities of producing media were considered, the optimum functional component bases were determined, the theory of structural organization was developed and methods of logic synthesis in the media and algorithmic parallelling devices to the level of microoperations were worked out. New problems were determined and new difficulties arose during the investigations. Development of microelectronics was not as vigorous as initially assumed, but the success achieved determined the solution of a number of problems. Thus, the extensive use of microprogramming and the appearance of microprocessor units and programmable logic matrices had a very important effect on the development of the idea of creating homogeneous structures. Development of theory of parallel processes influenced the solution of some software problems.

The concept based on a combination of devices for parallel representation of algorithms and methods of microprogram interpretation of them was established during the investigations. This concept was called parallel microprogramming. Devices for microprogram description of algorithms in limiting-parallel form, methods of interpreting this description by automaton networks, methods of asynchronous composition of algorithms, methods of embedding microprograms in logic matrices and language for microprogram description of parallel processing structures and a system for simulating their operation in an ordinary computer were developed on its basis.

All the foregoing is outlined in six chapters. The contents of the chapters are related. However, chapters 2, 5 and 6 can be recommended to those interested only in limit-parallel algorithms, while chapters 3 and 4 can be recommended to those who are working in the field of synthesis of asynchronous control and parallel processes ses, omitting from these chapters the few places which concern parallel substitution systems. Moreover, chapter 4 can be understood as an outline of the original method of synthesizing logic function systems for inclusion in programmable logic matrices and can be read separately..

The following persons participated in writing the book: P. A. Anishev--sections 3.1 and 3.3, S. M. Achasova--sections 4.1, 4.3 and 4.4, O. L. Bandman--chapter 1 and sections 3.2-3.5, S. V. Piskunov--chapter 5 and sections 6.1 and 6.4, S. N. Sergeyev--sections 2.2, 2.4, 2.5, 6.2 and 6.3. S. M. Achasova and O. L. Bandman wrote section 4.2 jointly, O. L. Bandman and S. V. Piskunov wrote section 3.4 jointly and S. V. Piskunov and S. N. Sergeyev wrote sections 2.1 and 2.3 jointly. Besides the enumerated authors, Yu. N. Kornev made an important contribution to development of the idea and methods.

The authors are deeply grateful to V. G. Khoroshevskiy for support and kind advice, to I. V. Ilovayskiy and Ya. I. Fet for valuable comments and useful discussions of the book and also to L. V. Alekseyeva for assistance in organizing the manuscript.

Contents

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CSO: 1863/241

TRANSFER OF BAMOS PROGRAMMING SYSTEM TO CONTROL OF OPERATING SYSTEM DISPAK

Moscow PERENOS SISTEMY PROGRAMMIROVANIYA BAMOS POD UPRAVLENIYE OS DISPAK in Russian 1980 (signed to press 25 Mar 80) pp 3-8

[Excerpt from the report "Transfer of BAMOS Programming System to Control of Operating System Dispak", by D. Karl, M. A. Kopytov, V. F. Tyurin and E. Yunker, Computer Center, USSR Academy of Sciences, 301 copies, 31 pages]

[Excerpt] 1. Introduction. Purpose of Paper

Active cooperation between the USSR and the GDR in the field of using the BESM-6 computer began at the moment when the internal systems software for the BESM-6 had already been mainly formulated in both countries in the form of independent operating systems (OS) and programming systems. The operating system DISPAK [expansion unknown] (the operating systems DUBNA, IPM and ND-70 were also developed in the USSR) of the MONITOR SYSTEM DUBNA and BESM-ALGOL programming system achieved the greatest distribution in the USSR. The operating system BAMOS (Batch-Processing Multilanguage Operating System), which (also like the operating system DISPAK) was essentially based on the first operating system--the D-68 for the BESM-6, was developed in the GDR for the BSM-6.

The MONITOR SYSTEM DUBNA (as of 1969) was taken as the basis in developing the BAMOS programming system.

Different systems interfaces were offered to users in both countries for developing their own programs as a result of this development of the systems software of the BESM-6, which caused specific difficulties in exchange of programs between the organizations of both countries.

Investigations were conducted in the USSR to transfer individual elements of the BAMOS programming system. The ALGOL-GDR and FORTRAN-GDR translators built into the MONITOR SYSTEM DUBNA were widespread among users in the USSR. The presence of these translators within the MONITOR SYSTEM DUBNA facilitated adaptation in the USSR of the programming systems developed in the GDR, but did not completely resolve the problems of transfer. Therefore, USSR and GDR system programmers agreed on joint investigations in 1974 to connect the BAMOS programming system to the operating system DISPAK.

The main purpose of this investigation was that any program or programming system which was developed for the operating system BAMOS could be realized without any modification on the BESM-6 under the control of the operating system DISPAK.

The work was conducted in stages during the period from 1974 through 1979. A number of USSR organizations utilized the investigation to operate specific programming systems developed in the GDR.

Two preprints were published in the USSR on the BAMOS-DISPAK programming system [20 and 21].

This preprint is a unique report on the investigation. The brief structural characteristics of DISPAK and BAMOS are presented in it and special attention is devoted to interaction between the operating system and programming system.

The characteristics of realizing BAMOS-DISPAK and the results achieved are then described.

In conclusion the authors consider the given paper among the common problems of program system transfer.

2. Principles of Joining

2.1. Functions and Structure of DISPAK

Multiprogramming is realized in DISPAK for 16 virtual channels (four for the paper tape operating system).

The information buffering mode is used extensively in the operating system as input and output information. This permist one to specifically organize effective loading of the central processor of the BESM-6. There may be up to 255 problems in the input buffers of the operating system and each problem reports information on the required resources to the operating system through special sections that comprise the problem certificate. A special planning part of the operating system from the total line of input problems selects the corresponding problems and transfers them for processing. The planning system algorithm takes into account the total volume of physical resources of the BESM-6, the presence of resources required for performance of a given task, the priority of the problem, its weight (some function of reading time and the volume of indicated resources) and also the specific mode of selecting problems for solution assigned by the human operator (actually the ratio between the number of "long" and "short" programs).

The operating system allocates the resources to the problem which occupied the virtual channel for processing according to the requirements of the problem. These resources are allocated statically and are attached to the problem during the entire time of solving it. One can demonstrate (and reject) only magnetic tapes and disks dynamically. The capacity of the internal storage should not exceed 32K words.

There is an apparatus (so-called basic capabilities of the operating system) in the disk version of the operating system which permits one to construct programming systems consisting of the main and subordinate problems which, occupying the same 16

virtual channels, can exchange resources and messages with each other. Information can be processed by means of this apparatus by using internal storage capacity greater than 32K words.

The operating system DISPAK supports the operation of BESM-6 complexes joined on the basis of a common disk memory. There is the capability of operating with magnetic tapes installed on different BESM-6 and on message exchange between machines. These capabilities are essentially sufficient to construct systems under the control of the operating system DISPAK which could be used by the aggregate resources of several BESM-6 computers.

A set of programming systems operates under the control of the operating system DISPAK. The operating system "knows nothing" about the internal structures of the programming systems. The operating system only supports a specific set of functions (extra codes) required for functioning of the programming systems. The operating system also makes available specific information security devices to programming systems. Most programming systems do not now utilize the basic capabilities of the operating system DISPAK (but these devices can operate at the level of fulfilling the working program) and operate in the area with capacity of no more than 32K words. The programming systems are arranged on a special disk (tape), from whence each problem belonging to a specific programming system loads the corresponding parts of the given programming system into its own internal storage. The programming system thus operates on the resources of a specific user problem in the mathematical mode. All the specific functions are realized by means of the extra codes of the operating system DISPAK. This method of organizing the work of programming systems (outside operating systems) has both its positive and negative aspects. The following should be included among the negative aspects.

Each programming system is forced to have its own "instrument" components: a monitor, editor, loader and so on. For this reason the user experiences difficulties if he must use components (for example, libraries) of different programming systems. This disadvantage is smoothed over in real operation by the fact that the multilanguage programming system MONITOR SYSTEM DUBNA is finding ever wider distribution at most computer centers.

A positive aspect in this organization of operating system and programming system interaction is that there is definite simplicity in connection of any new programming system. The programming system should be oriented only toward the set of extra codes of the operating system DISPAK. This partially explains the fact of how rapidly the BAMOS programming systems could be connected to the operating system DISPAK.

2.2. Functions and Structure of BAMOS

The bench processing mode using multiprogramming that provides effective use of a central processor and internal storage is realized in the BAMOS.

The specific goals of developing the BAMOS also included the following:

--connection of different computers (Siemens 4004/26, YeS-1020 and control computers of TPAI type) to the BESM-6;

--connection of nonstandard peripheral equipment to the BESM-6;

--realize remote batch processing by using government communication lines (the GDR mail system).

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CSO: 1863/247

TECHNOLOGY OF DEVELOPING CONTROL COMPUTER COMPLEXES USING YAUZA-6 PROGRAMMING AND DEBUGGING AUTOMATION SYSTEM

Moscow VYCHISLITEL'NYYE SISTEMY in Russian No 2, 1981 (signed to press 16 Mar 81) p 168

/Table of contents from the collection "Computer Systems", edited by E.V. Yevreinov, Izdatel'stvo "Finansy i statistika", 15,000 copies, 168 pages/

/Text/ 1. Development and Improvement of Computer Systems

2. Automation and Mechanization of Accounting and Computer Operations

6521
CSO: 1863/252

TECHNOLOGY OF DEVELOPING CONTROL COMPUTER COMPLEXES USING YAUZA-6 PROGRAMMING AND DEBUGGING AUTOMATION SYSTEM

Moscow VYCHISLITEL'NYYE SISTEMY in Russian No 2, 1981 (signed to press 16 Mar 81) pp 38-56

[Article by V. V. Lipayev, doctor of technical sciences, professor, L. A. Serebrovskiy, candidate of technical sciences, F. A. Kaganov, B. A. Korepanov, M. A. Minayev and A. A. Shtrik, candidate of technical sciences, from the collection "Computer Systems", edited by E. V. Yevreinov, Izdatel'stvo "Finansy i statistika", 15,000 copies, 168 pages]

[Excerpts] A significant shift has been noted recently in the approach to software development (MO) for control computers and specifically for specialized machines (STsVM [Specialized digital computers]). Whereas attention was concentrated mainly in early developments of technology on programming languages and means of program translation, complex program design systems, including debugging devices, were subsequently developed. The need to develop complete program design technology, beginning with development of algorithms and ending with embodiment of the debugged program as a software article, its documentation and accompaniment during circulation,has now become obvious [1, 2]. The characteristic features of the structures and specifications of STsVM require development of the technology for working out programs based on cross-systems realized on powerful production (instrument) universal type digital computers.

An example of taking this approach toward development of control computer complexes (KUP) may be the YaUZA system [3]. The first version of the YaUZA-1 programming automation system based on the M-220 production digital computer (1970-1975) mainly performed functions of program translation and did not solve debugging problems. The first versions of the YaUZA-6 programming and debugging automation system SAPO based on the BESM-6 digital production computer (1975-1977) were developed as adapted cross-systems that perform a rather wide range of complex of problems of design, debugging, development control, STsVM program documentation and so on. Modern versions of the YaUZA-6 SAPO (1980) in combination with benches for complex dynamic debugging provide a complete production cycle of program development for a wide range of control and specialized digital computers. The production process of developing KUP for STsVM can generally be divided into the following phases (Figure 1):

The first phase is general design of the control system and the algorithms, including determination of the system problems, selection of control methods, the

type of specialized digital computers, methods of organizing calculations and the structure of control program complexes, formulation of general and special algorithms and organization of the STsVM memory;

The second phase is preparation of hardware, which includes adaptation of the cross-system for a specific STsVM, preparation of the SAPO data base and working out instructional materials from programming and debugging technology;

The third phase is development of programs, including writing the programs in algorithmic languages, macrolanguages or autocodes and translation, monitoring and loading of the programs into the STsVM memory;

The fourth phase is program debugging by determined tests through an instruction interpreter, obtaining the statistical and time characteristics of programs and checking the connections of program control and information modules;

The fifth phase is production of machine carriers for program input into STsVM and documentation of the program complex.

These phases require a rather powerful digital production computer. Moreover, program development includes phases of final complex dynamic debugging and testing;

The sixth phase is complex dynamic debugging of the KUP based on the STsVM with use of simulation benches to model the external conditions of using the STsVM in the control system;

The seventh phase is half-scale or full-scale tests using real control facilities or simulators of them to check the efficiency and characteristics of KUP during functioning of the system under conditions which were formulated by assignment of the control system for development.

The latter two phases are usually conducted by using special equipment and are not considered in this paper. After development and testing of the KUP has been completed, the complex can be circulated, modernized and corrected during the entire operating time of the system. To do this, the technology of accompanying the KUP, which can be based to a significant degree on program design devices, should be developed.

The first five of the indicated phases of the unified production process for design of complex program systems using the YaUZA-6 SAPO are described below.

Conclusions

The considered phases of program development using the YaUZA-6 SAPO have unified engineering, programming and organizational bases. The unity of the engineering base includes the fact that the control program complex is being developed and being debugged autonomously on a single digital production computer--the BESM-6. Whereas STsVM have devices for autonomous program debugging and correction, the unified technology requires organization of a channel for the STsVM to communicate with the digital production computer for operational exchange of KUP variations and support of design unity. Dynamic debugging on simulation benches permits the use of other digital production computers as well.

The unity of the programming base is supported by the general design data base which contains the initial texts of all programs, libraries of absolute or load modules, certificates of translated programs, descriptions of global variables, debugging assignments and also other data on the KUP and individual programs.

The unity of the organizational base includes monitoring the progress of programs through the phases of the production process, keeping an account of the results of each phase, the expended resources and the number of errors of one or another type. Moreover, the command supervisor accomplishes automatic monitoring of the course of design with various degrees of detail.

The standardized technology of transfer of the YaUZA-6 SAPO by users to other organizations should especially be determined, in which the following is transferred:

a magnetic tape with a copy of the standard reference version of the SAPO adjusted to the standard STsVM;

a copy of the reference magnetic tape containing test and control information;

a control pack with complete control task that checks the operation of the subsystems of the YaUZA-6 SAPO;

a model for unsealing the standard output information.

A complete set of the operational documentation formulated as enterprise standards is also transferred. The complete set of standards (31 standards) contains information on the system as a whole and about each subsystem for describing the SAPO, programming and debugging control languages and also supervision on preparation and operation of the system.

The technology of transferring the YaUZA-6 SAPO permits the user not only to become familiar with the system but also to assimilate all of its operating modes on the example of the standard STsVM and then to convert to adaptation of the system for a specific STsVM.

The YaUZA-6 SAPO consists of 23 subsystems that realize the enumerated problems. The SAPO is adapted to different conditions of application (different STsVM, autocodes and command characteristics) by the automated method through the adjusting devices included in the SAPO. The overall program capacity of the SAPO comprises 330,000 of the BESM-6, of which 302,000 are machine-independent and remain unchanged when the STsVM is replaced. Information modules for adjustment to the STsVM and the command comprise 16,000 words, while the machine-independent program procedures occupy approximately 12,000 words. The YaUZA-6 SAPO was adjusted to 26 types of STsVM in 14 organizations during the period from 1976 through 1980.

6521
CSO: 1863/252

ABSTRACTS FROM THE JOURNAL 'PROGRAMMING', JULY-AUGUST 1981

Moscow PROGRAMMIROVANIYE in Russian No 4, Jul-Aug 81 pp 95-96

[Text]

UDC 519.1

SEMIGROUP MODELS OF PROGRAMS

[Abstract of article by Podlovchenko, R. I., Yerevan]

[Text] Given in this article are the sufficient conditions for a formal model of programs to have a semantic model equivalent to it; thus the concept of a semigroup model appears. The problem of equivalence of schemes of programs is considered for the semigroup model. Bibl. of 4 titles, 2 figs. and 3 tables.

UDC 681.323

LANGUAGE FOR GRAPH-SCHEMES OF PARALLEL ALGORITHMS AND ITS EXPANSION

[Abstract of article by Aref'yev, A. A.; Korablin, Yu. P. and Kutepov, V. P.]

[Text] Described in this article is a language for graph-schemes of parallel algorithms and its expansion oriented to: a) effective description of parallel schemes dynamically adjustable to the needed level of parallelism as a function of the values of the parameters to be computed; and b) multilevel hierarchical representation of graph-schemes that simplify the process of developing them. Bibl. of 7 titles, 9 figs.

UDC 681.142.2

MODIFICATION OF LR(k)-PARSER FOR PARALLEL SYNTAX ANALYSIS

[Abstract of article by Babichev, A. V.]

[Text] A class of MLR(k)-grammars, an expansion of the class of LR(k)-grammars, is introduced. The strategy of syntax analysis of languages produced by MLR(k)-grammars is described. Solvability of problems of membership of unambiguous KC [context-free] grammar in the class of MLR(k) for a given k is shown.

Methods of Programming

UDC 681.142.2

OPTIMIZATION OF CODE FOR ARITHMETIC EXPRESSIONS

[Abstract of article by Stepanov, A. N.]

[Text] A method of realizing an algorithm for generating optimized postfix notation of expressions in a push-down list translator is discussed. The structure of the translator and instructions to control lists in generating code are described. This method is oriented to hardware implementation in computers with a high-level machine language. Bibl. of 5 titles, 1 fig.

UDC 681.3.06.44 : 62-52

CHARACTER OUTPUT IN PROGRAM SYSTEMS (MINI-FORMATTERS)

[Abstract of article by Belokopytov, Yu. A.; Kaminskiy, L. G.; Klimenko, S. V.; Lebedev, A. A. and Polovnikov, S. A., Serpukhov]

[Text] Authors present a method of organizing character output in program systems based on developing a package of subroutines to form the lines to be output. Advantages of this method are discussed. Bibl. of 8 titles.

Computer Software and Systems Programming

UDC 518.5-512.831

MATRIX COMPUTATIONS IN MULTIPROCESSOR COMPUTERS WITH COMMON STREAM OF INSTRUCTIONS

[Abstract of article by Sukhov, Ye. G.]

[Text] Questions of realization of basic matrix algorithms on multiprocessor computers with a common stream of instructions (SIMD architecture) are discussed. Complexity of algorithms is evaluated in terms of matrix multiplications of the dimension (W x W). Requirements for matrix computers are formulated and questions of organization of calculations are discussed. Bibl. of 5 titles.

UDC 681.8.06 : 51

USING FUNCTIONALLY EQUIVALENT MODULES IN DEVELOPING PROGRAMS FOR DIGITAL CONTROL COMPUTERS

[Abstract of article by Bergson, A. and Raud, R., Tallin]

[Text] Authors discuss use of functionally equivalent modules (FEM) in the language of process control computers. They discuss problems of obtaining FEM and organization of joint execution of programs in languages of various computers. Bibl. of 5 titles.

UDC 681.3.06

SYSTEM OF ANALYTIC COMPUTATIONS IN ALGOL IN 'DUBNA' MONITOR SYSTEM

[Abstract of article by Dem'yanovich, Yu. K., Leningrad]

[Text] Author describes system of analytic computations in ALGOL-GDR ("SAVAG") which makes it possible to perform differentiation, identity transformations (factoring out common multiplier, combining like terms, removing parentheses and others), transformations with trigonometric expressions and other operations. Bibl. of 9 titles.

UDC 681.3.06

DATA TRANSMISSION FACILITIES FOR REAL-TIME SUPERVISOR

[Abstract of article by Naumov, V. V. and Petrakov, S. A.]

[Text] Authors discuss data transmission facilities of the applications program package "Real-Time Supervisor," that supports automatic exchange of data between peripherals of an arbitrary type, in particular Unified System peripherals and data queues. Bibl. of 1 title, 1 fig.

Complex Systems and Their Software

UDC 681.31 : 681.326 : 681.142

METHODS OF SEARCHING FOR FREE COMPUTER IN DISTRIBUTED COMPUTING SYSTEMS

[Abstract of article by Gavrilov, A. V. and Zhiratkov, V. I., Novosibirsk]

[Text] Authors discuss problem of searching for a free computer to execute a job that has come in in distributed computing systems (RVS). To solve this problem in large distributed computing systems, they suggest using decentralized methods of search with incomplete information. Results of computer studies of them are given. Bibl. of 7 titles, 4 tables, 1 fig.

Communications

UDC 681.142.2+513.83:519.55:518.5

ENUMERATION OF PARTIAL GRAPHS WITH A GIVEN CYCLOMATIC NUMBER

[Abstract of article by Mazepa, Ye. Yu.; Silin, I. N. and Fedyun'kin, Ye. D., Dubna]

[Text] A fast algorithm for searching for all partial graphs with a given cyclomatic number is suggested based on analysis of topological properties of a graph. The algorithm can be used to solve problems of optimal programming and for optimization of networks.

Application of the algorithm for optimization of urban power netowrks has yielded a tangible economic effect. Bibl. of 7 titles, 7 figs.

UDC 681.142.2

SPALM SYSTEM OF PROGRAMMING AND SIMULATION LANGUAGES

[Abstract of article by Sedol, Ya. Ya., Riga]

[Text] Author discusses SPALM system of programming and simulation languages that contains languages of various levels and functions, united by common principles of construction. SPALM has been implemented on the Unified System of Computers. Bibl. of 9 titles, 6 figs., 2 tables.

8545
CSO: 1863/255

PROSPECTS FOR SYSTEMS AND THEORETICAL PROGRAMMING

Novosibirsk PERSPEKTIVY SISTEMNOGO I TEORETICHESKOGO PROGRAMMIROVANIYA in Russian 1979 (signed to press 17 Dec 79) p 3

[Table of contents from the collection: "Prospects for Systems and Theoretical Programming", edited by Igor' Vasil'yevich Pottosin, Computer Center, Siberian Department, USSR Academy of Sciences, 800 copies]

Contents Page

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CSO: 1863/241

UDC 658.012.011.56:681.3.06

AUTOMATED CONTROL SYSTEM SOFTWARE RELIABILITY

Moscow NADEZHNOST' PROGRAMMNOGO OBESPECHENIYA ASU in Russian 1981 (signed to press 19 Mar 81) pp 2-6, 241

[Annotation, preface and table of contents from book "Automated Control System Software Reliability", by Vladimir Vasil'yevich Lipayev, Energoizdat, 10,000 copies, 241 pages]

[Text] Author discusses problem of ensuring reliability of complex software systems for control from the positions of modern systems engineering, methods of enhancing reliability of the components and the software system as a whole, and methods for checking functioning. Factors affecting reliability are analyzed.

For engineers and technicians engaged in design and operation of various types of automated control systems and for students in VUZ's and post-graduates studying corresponding specialties.

Preface

The theoretical and practical level of the modern theory of reliability of hardware is rather high, and not one complex hardware system is designed without a simultaneous analysis of its future reliability. To ensure a given hardware reliability, a broad spectrum of methods and means are used that allow developing highly reliable complex systems from relatively unreliable components. These methods and means use various forms of redundancy to prevent failures and minimize their effect on the quality of functioning of the systems. A new type of product--complex software systems for information control and processing systems--has recently entered the area of interests of the theory and practice of the study of reliability. During operation of such systems, malfunctions and failures occur that have been caused by distortions of programs and data. These distortions not only occur in connection with anomalies of operation of apparatus, but can also show up during trouble-free operation of the computer that implements the given software system. The critical importance of the systems that control and process information has dictated the need of studying the causes of software failures and methods of countering them.

The absence of aging and physical destruction of software has led to the emergence of the view by a number of experts that methods of the existing theory of reliability are wholly inapplicable to the study of the reliability characteristics of software. However, analysis of the malfunctions and failures during prolonged operation of complex software systems has allowed finding analogies to hardware breakdowns and

failures. A number of concepts, problem statements and methods of analysis of hardware reliability have been successfully applied to the study of software reliability. A new branch of the general theory of reliability has begun to be developed: the theory of software reliability; its subject of study is the serviceability of complex software systems for control and processing of information.

The major factors in ensuring software reliability, just as for hardware reliability, are the various forms of redundancy: structural, informational and temporal. Redundancy allows monitoring of software functioning processes and data validity, and preventing failures or reducing their effect on system efficiency. Resources for using redundancy in a program have always been limited; this leads to the need of rational distribution of resources between various forms of redundancy and various methods of raising software reliability.

The lack in the majority of cases of physical destruction and need of repair of programs has raised sharply the possibility of automatic restoration of programs after their failures without human participation. There has arisen the problem of quantitative research and development of methods of expeditiously restoring programs and data that enable reducing the period of restoration and consequences of the failure to the level of a short-lived malfunction. It has proved possible to distinguish the phenomenum of malfunction and failure by time of restoration, the tolerable values of which in turn are a function of the inertia of the subscribers--the sources and consumers of the information.

In chapter 1 of this monograph, the main problems of studying an enhancing the reliability of complex software systems are considered; the factors affecting software reliability and the features of applying the main concepts and mathematical apparatus of reliability theory to these products are investigated; and the methods and criteria of evaluating software reliability and prerequisites for determining the various indicators of reliability are analyzed.

In chapter 2, the characteristics of disturbances capable of causing malfunctions and failures during functioning of programs are generalized; garbling of source data coming from the human operator and garbling caused by malfunctions in data transmission systems are considered. Special attention is paid to investigating the statistical characteristics of errors in software systems and to the methods of describing them.

Chapter 3 generalizes the methods of designing reliable software systems. In it, features of structural design of individual subprograms, data files and software systems as a whole are considered; methods of checking the correctness of standard program structures are formalized; and the main methods of determinate testing of programs in the process of debugging them and eliminating errors are presented. Considerable attention has been paid to determining the state of debugging of programs and the link between indicators of the state of debugging and software functioning reliability. Here an analysis has been made of the problem of statistical checking of software system reliability in the process of debugging it and tests aimed at determining the main indicators of reliability.

In chapter 4, methods of using redundancy to check functioning of programs and to expeditiously restore them after malfunctions are presented. Methods of evaluating the quality of algorithmic and program guarding against malfunctions and failures

during program operation are given. Optimization of outlays for introduction of redundancy and debugging of programs to ensure prescribed reliability of their functioning is considered.

Given in the appendix is the general technology of design of reliable software systems that considers the limitation on resources to be allocated to ensure reliability.

The importance of the problem of quantitative study and enhancement of reliability of software functioning is confirmed by the materials of all-union [41] and international [76, 77, 88] conferences and is reflected in the sharp increase in the number of journal articles in this field [8]. There are no generalizing books on software reliability in the domestic literature and the author hopes that this book will fill this gap to some extent. One would expect that a number of serious generalizing studies will be devoted to this problem in the near future to create the bases for the theory of software reliability.

Production of software systems is developing rapidly and accordingly the theoretical base is developing to analyze and synthesize them. Nevertheless, many concepts are just forming and there is a lack of precise definitions of a number of new terms that have appeared. Even such major terms as mathematical and program facilities [software] [matematicheskoye i programmnoye obespecheniye] cannot always be separated. The author uses primarily the terms software [programmnoye obespecheniye] and software systems [kompleksy programm]. Attempts have been made to refine and complete the definition of a number of terms used in analyzing software reliability, however there is still much work to be done in the field of software terminology.

Reliability is a major indicator of the quality of software; however, it is still characterized by a number of functional and design criteria of quality, the selection of which to a considerable extent is a function of its purpose. Being used more and more extensively to evaluate the constructive characteristics of programs are the efficiency of use of storage and throughput of the computer, complexity, correctness, structurization, mobility, documentability, cognizability and other criteria. A precise measurement of the actual values of indicators of quality of the program product is becoming an ever more important problem as a consequence of the increase in software production volume, the increase in its complexity, and as a result of the increase in importance of the functions performed by software systems in various fields of the national economy. It is necessary to develop unified methods of measuring, monitoring and forecasting of program quality indicators as well as of the outlays to achieve them and to provide an objective evaluation of the quality of each program.

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The Author

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OPTICAL PROCESSING

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HYBRID OPTICAL-DIGITAL PULSAR SIGNAL PROCESSING SYSTEM

Leningrad RADIOGOLOGRAFIYA I OPTICHESKAYA OBRABOTKA INFORMATSII V MIKROVOLNOVOY TEKHNIKE in Russian 1980 (signed to press 24 Oct 80) pp 135-140

[Article by N. A. Yesepkina, N. A. Bukharin, Yu. A. Kotov, B. A. Kotov and A. V. Mikhaylov from the collection "Radio Holography and Optical Information Processing in Microwave Equipment", edited by corresponding member of USSR Academy of Sciences L. D. Bakhrakh and candidate of technical sciences A. P. Kurochkin, Scientific Council on Problems of Holography, Department of General Physics and Astronomy, USSR Academy of Sciences, Izdatel'stvo "Nauka", Leningradskoye otdeleniye, 2,150 copies, 184 pages. Additional sections of this book appeared in the USSR REPORT: CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY dated 28 August 1981 (JPRS L/9945) pp 1-39]

[Text]

1. Much attention of radioastronomers has recently been attracted by the investigation of pulsars, which are point sources emitting wideband signals in the form of periodic short pulses. Because of scattering of the interstellar medium, the pulse length on earth considerably exceeds their length near the radiation source and may comprise tens and even hundreds of milliseconds. The effect of scattering also leads to the reduction of the amplitude of the signals being received.

Several methods of eliminating the effect of scattering in observing pulsars are known in which multichannel electronic systems or digital correlators are used [1]. These methods are similar to those of complex signal processing with large multiplication of the band by the pulse length ($\tau\Delta f \gg 1$).

We feel that acoustooptical devices [2], specifically devices that permit correlation processing of wideband signals of long length, are promising to eliminate the effect of scattering when observing pulsars. These are acoustooptical correlators with time integration [3] in which special photodetectors (for example, devices with charge coupling) that integrate or store the signal are used. Unlike ordinary acoustooptical correlators [3], in which the correlation function is shaped sequentially in time, the correlation function in the devices under consideration is calculated simultaneously for different time shifts of the initial functions by time integration, i.e., the following function is formed at the output of this correlator

$$\Phi(t') = \int_0^T u(t)\, u(t - t')\, dt$$

where all values of t' lying in the interval from -D/2S to D/2S, where D and S are the aperture of the acoustic drive of the acoustooptical modulator and the velocity of the elastic wave in it, T is integration time and u(t) is the received signal.

The possible length of the signals being processed T in these systems, when using photodetectors based on charge coupling devices (PZS) [4], comprises from units to hundreds of milliseconds and it may be increased significantly by using an additional computer buffer storage.

The maximum storage time used in this correlator and consequently the maximum improvement of the signal/noise ratio received at the system output, is limited by the dynamic range of the photodetectors being used R (in our case the dynamic range of the PZS [3]) and comprises $\tau\Delta f \leq R^2$.

The required time for storing the acoustooptical modulator is determined by the maximum possible pulse length near the radiation source.

The bandwidth of the devices being considered is determined by the acoustooptical modulator band and can reach hundreds of megahertz [5, 6].

2. One of the possible schemes of an acoustooptical correlator with time integration, which can be used to process pulsar signals, is presented in Figure 1. As can be seen from the figure, the signal u(t) from the antenna A, which receives the pulsar radiation, is fed through a power divider DM to two independent receivers P1 and P2 and after amplification and conversion to an intemediate frequency , is fed to the two channels of the correlator that calculates the autocorrelation function of the input signal. Two receivers are required so that the natural noise of the device $N_1(t)$ and $N_2(t)$ are not correlated with each other in different channels. As can be seen from Figure 1, the signal $u(t) + N_1(t)$ from P1 modulates the OKG [laser] emission by means of intensity modulator M. The light is then split by means of a collimeter consisting of lenses L_1 and L_2 and impinges on the acoustooptical modulator AOM, onto the piezotransducer of which the signal $u(t) + N_2(t)$ from P2 impinges. A travelling ultrasonic wave is propagated in this modulator, which ensures a time shift of the signals required to calculate the correlation function. Lenses L_3 and L_4 shape the image of the AOM in the output plane of device R3, where the linear components of the PZS are located. The undiffracted part of the light is filtered in plane R_2. The signal at the output of each of the linear components of the PZS is proportional to the time integral due to the light intensity impinging on it.

One can show [4] that the following signal is shaped at the output of the considered device

$$\Phi\left(\frac{x}{s}\right) = AI_0\left\{T + a\psi_m \int_0^T u(t)\, u\left(t - \frac{x}{s}\right) dt + a\left(\frac{x}{s}\right)\right\}, \qquad (1)$$

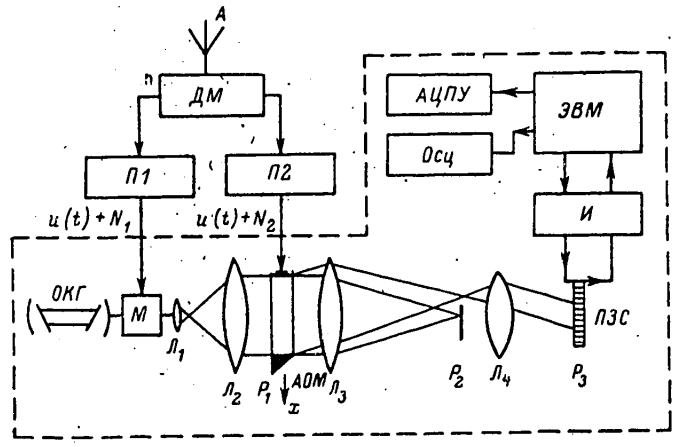

Figure 1. Diagram of Acoustooptical Correlator With Time Integration

where I_0 is the laser emission intensity, a and A are constant values, ψ_m is the modulation index of light by the acoustooptical modulator, x is the coordinate in plane R_1 and s is the speed of light in the sound conductor of the modulator.

The second term in this expression is the desired autocorrelation function and the first is a constant component. The term $\alpha(x/s)$ contains cross-correlation functions and reduces the signal/noise ratio at the device output [7].

As can be seen from (1), the autocorrelation function at the output is formed as a function of coordinate x, i.e., the signal distribution in the linear series components of the PZS corresponds to the desired autocorrelation function. These signals are transferred by the control pulse coming from the computer to the storage sections (the linear shift registers of the PZS) and are then fed sequentially by a special interface [8] to the Elektronika-100 computer.

After the necessary processing, the signals are fed to an oscillograph (OSTs), to an automatic digital printer (ATsPU) and so on. Thus, the considered device is a hybrid optical-acoustical processing system in which correlation analysis is accomplished in the optical system. The remaining processing is accomplished in a computer that permits the operating modes of the correlator to be changed by program, for example, to print out the results of observing individual signals, to operate in the pulse storage mode and so on.

3. We developed and investigated a mockup of an acoustooptical correlator which can be used to process pulsar signals. An acoustooptical moculator was also used as the modulator M. Both modulators operated on a frequency of 30 MHz and had a band of 3 MHz.*

*Use of modulators [5, 6, 9] operating at higher frequencies permits an increase of the working band of the device.

The Elektronika-100 computer was used in our experiments. The investigation was conducted in two modes. In the first storage was carried out only in the PZS of the components and in this case storage comprised T = 10 ms; in the second mode an additional computer memory was introduced where the results of 10 separate millisecond storage cycles were added.

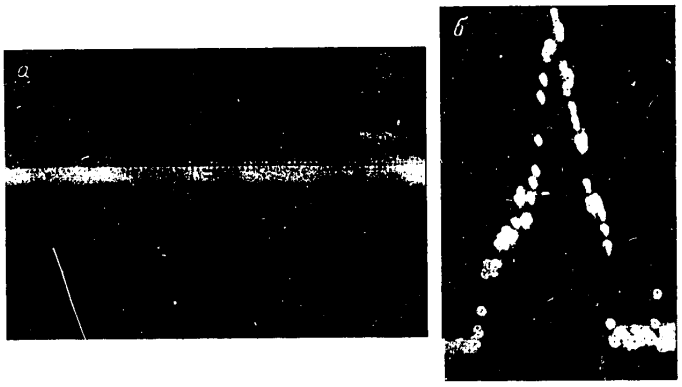

Figure 2. Signal at One of the Correlator Inputs (a) and Signal at PZS Output (b) at T = 10 ms

Noise signals from two noise generators were fed to the outputs of the correlator, in addition to identical pulse signals (ΔF = 260 kHZ) that simulate pulsar signals. These signals simulated the input noise of the receivers.

A signal 10 ms long at one of the correlator inputs is shown in Figure 2, a. The result of processing it, achieved at the linear output of the PZS, is illustrated in Figure 2, b. Each point on the photograph corresponds to a separate linear component of the PZS, while the vertical deflection is proportional to the value of the signal on it. The distance between adjacent linear components comprised 0.32 microsecond in the time scale in our case. As can be seen from Figure 2, b the half-width of the autocorrelation function is equal to $\tau \approx 3.9$ microseconds at calculated value of $\tau = 1/\Delta F \approx 3.8$ microseconds. Thus, the derived contraction coefficient comprised $K = T/\tau = 2{,}500$.

Similar experiments were conducted with signals T = 1.28 second long, when not only the linear components of the PZS were used for storage but the memory of the Elektronika-100 computer as well. In this case a contraction coefficient $K = 3 \cdot 10^5$ was obtained. It is obvious from the given results that the signal is confidently separated from the noise at the correlator output.

Thus, one can hope that the use of acoustooptical devices will make it possible to simplify the pulsar signal processing system and to improve the parameters of receiving systems.

The correlation devices considered here can also be used to process interferometer signals, specifically multicomponent radiotelescopes with aperture synthesis [10] and in this case devices based on spatial-multichannel modulators [9, 11] are of special interest. These devices are very promising not only to process signals in radioastronomical but in other different radioengineering systems where correlation processing of wideband signals of great length must be carried out.

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6521
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MEASURING COORDINATES OF TERRAIN REFERENCE POINTS AND DETERMINING SHIFTS OF CLOUD FORMATIONS BY MEANS OF HETERODYNE OPTICAL CORRELATOR

Leningrad RADIOGOLOGRAFIYA I OPTICHESKAYA OBRABOTKA INFORMATSII V MIKROVOLNOVOY TEKHNIKE in Russian 1980 (signed to press 24 Oct 80) pp 140-155

[Article by A. I. Balabanov, G. Ye. Korbukov, A. A. Feoktistov and Ye. R. Tsvetov from the collection "Radio Holography and Optical Information Processing in Microwave Equipment", edited by corresponding member of USSR Academy of Sciences L. D. Bakhrakh and candidate of technical sciences A. P. Kurochkin, Scientific Council on Problems of Holography, Department of General Physics and Astronomy, USSR Academy of Sciences, Izdatel'stvo "Nauka", Leningradskoye otdeleniye, 2,150 copies, 184 pages. Additional sections of this book appeared in the USSR REPORT: CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY dated 28 August 1981 (JPRS L/9945) pp 1-39]

[Text] Introduction

Correlation processing can be used for cosmic video information in at least two aspects: for coordinate tying of images of the earth's surface and other planets obtained at different moments of time and from different sensors and for extracting meteorological data.

When investigating the chronological changes in cosmic photoimages and when the images obtained in different spectral bands are compared, it becomes necessary to join them precisely. Accurate correction of the geometric distortions of the images being joined should be carried out to ensure the possibility of this joining. Data for this correction can be obtained by correlation detection of the fragments of the photoimages to be corrected and the measurements of the coordinates of terrain reference points [1]. It is obvious that the presence of the indicated geometric distortions will have a negative effect on the reliability of recognition; therefore, preliminary correction of these distortions is necessary, which is accomplished when the image is recorded.

To gather data on the direction and velocity of wind in different sections of the globe, space photographs of the cloud cover transmitted from geosynchronous satellites at intervals of 30 minutes are used more extensively. The required data are obtained by recognition and measurement of the motions of individual cloud formations. The negative factor here that affects the reliability of identification when using the correlation method may be deformation of the cloud formations. Extensive experimental investigations on a sufficient number of images must be conducted to

determine the boundaries and conditions of applicability of the correlation method in this problem, the same as in the previous problem.

The given paper is the initial attempt to conduct these investigations by using an optical heterodyne correlator (OGK) circuit [2]. Its main advantage compared to the known holographic matched filtration circuit [3] includes the absence of the need to manufacture holographic filters for reference images along with retaining the very valuable capability of spatial filtration of the frequency features which coherent optics gives. Moreover, the OGK scheme has a potentially higher instrument accuracy due to the photoelectric correlation image readout system and due to the absence of such error sources as aberration, inaccurate focussing, spatial noise and nonlinear distortions of the holographic filter and the objective of the second Fourier transform.

We recall that there are two spatially dispersed input apertures in the OGK scheme: one for the reference slide h (plane P_1) and the other for the signal slide g (plane P_2) (Figure 1). The image of the signal slide g_{+1} is superimposed on the image of the reference slide h_0 in the plane of diaphragm E (plane P_6) by with a hologram lens GO in the first Fourier plane P_4 created by lens L_1 (plane P_3) upon illumination of the input slides h and g by a parallel coherent light beam. Images h_0 and g_{+1} were multiplied out and spatial integration was accomplished by a quadratic photodetector of the FEU [photomultiplier]. Since the moving image of the signal slide g_{+1} has a doppler shift of light frequency proportional to the spatial carrier frequency and the rate of motion of the hologram lens in the Fourier plane, electrical oscillations with doppler division frequency whose envelope describes the cross-correlation function of the input images as the hologram lens moves, occur at the FEU output. This envelope was observed on the oscillograph screen after additional electric filtration and detection. The images were processed with suppressed optical constant of the component for which the point shutter 3 was introduced to the center of the Fourier plane P_4 directly in front of the hologram lens. Thus, the outline images were actually subjected to correlation processing. Moreover, additional spatial filters OF could be introduced in the second frequency plane P_8 formed by lens L_2 (plane P_6) in front of the photocathode of the FEU to optimize the signal/noise ratio at the correlator output. Accordingly, the positions and dimensions of the reference fragment were established by regulation the position and dimensions of rectangular diaphragm E (which was two crossed micrometric slits). The fragment of the reference slide established by means of diaphragm E usually had two squares with side of 1.8 mm in all the measurements.

Investigations were conducted on a mockup of the OGK in which a hologram modulator in the form of a drum 200 mm in diameter with 17 hologram lenses having focal distance of 300 mm fixed on 35-mm Mikrat-900 photographic film, was used. The drum was rotated uniformly at a speed of 1 rpm by an electric motor with friction reducer. Thus, the scanning period of the signal image with respect to the reference fragment comprised 59 ms through the X axis. An electronic oscillograph of type S1-55, the scanning of which was synchronized by passing the hologram lenses through the optical axis of the correlator, was used for the measurements. An example of correlation recognition of an image fragment of the earth's surface is shown in Figure 2. The illuminated square in the photograph of Figure 2, a denotes a fragment selected as a reference fragment while the entire photograph denotes the signal slide. Scanning is along the horizontal.

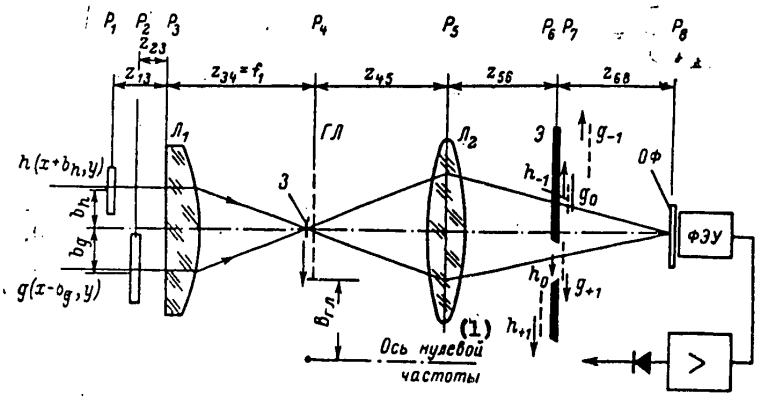

Figure 1. Diagram of Optical Heterodyne Correlator

Key:
1. Axis of zero frequency

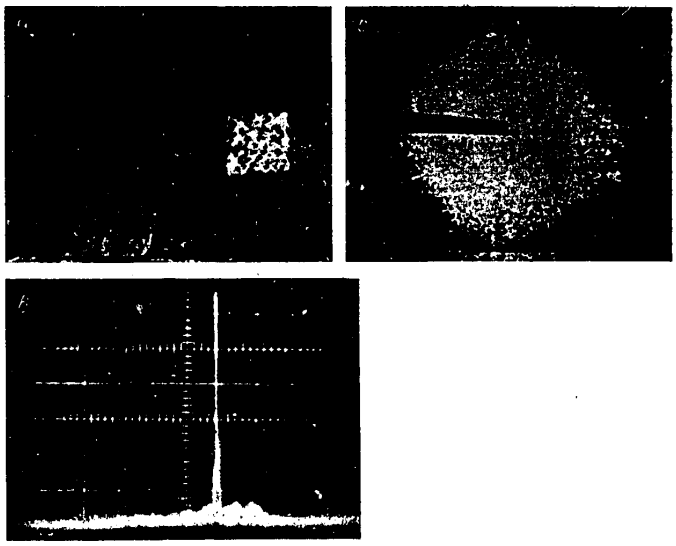

Figure 2. Example of Correlation Detection of Image Fragment with Complex Structure in OGK: a--input slide (signal); illuminated fragment is identical to that used as reference; b--pattern of Fourier plane of OGK: the flag covers the uninformative bright central part of the spectrum; c--signal at OGK output: the signal peak corresponds to the moment of total coincidence of the fragment noted in (a) with the reference image

An oscillogram of the correlation signal is shown in Figure 2, c. The peak corresponds to detection of the fragment in the signal image identical to the reference fragment. The oscillogram of Figure 2 b is a central cross-section of a two-dimensional cross-correlation function of the reference fragment and the signal image produced by search motion of the signal slide along the Y axis.

1. Investigation Correlation Identification of Fragments of Photographs of the Earth's Surface

Space photographs of sections of the earth's surface (region of the Volga upland) obtained from Meteor satellites on 1 and 15 September 1976 in the spectral range of 0.6-0.7 micron (Figure 3) were used for experiments in correlation identification using the OGK. The indicated images were processed on a computer, at the input of which preliminary correlation of the geometric images was carried out.

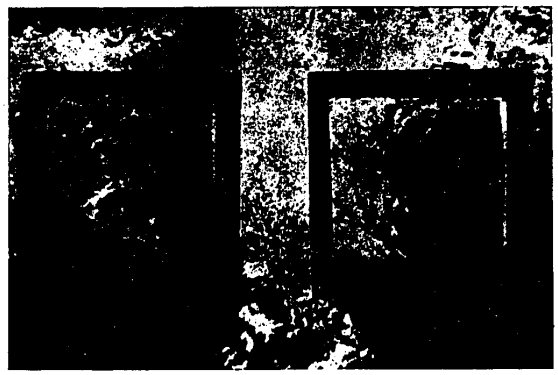

Figure 3. Fragments of Space Photographs of Section of Earth's Surface

The image component had the shape of a rectangle with dimensions Δl_x = 50 microns and Δl_y = 200 microns. To increase contrast, the photographs were subjected to contact printing on contrast photographic paper with subsequent rephotographing on Mikrat-300 film. Rephotographing occurred with reductions of 1:1, 1:2, 1:4 and 1:8. The dimensions of the image components corresponding to the scales are presented in Table 1.

Since Δl_x is one-fourth the size of Δl_y, the requirements on the accuracy of determining the motion in the direction of the X axis are considerably higher. For this reason the accuracy of measuring the coordinates of the fragments was determined along the X axis in conducting the given investigation.

The accuracy of determining the coordinates was estimated in the following manner. The signal slide was moved along the X axis and at the same time the position of

Table 1. Dimensions of Image Components at Different Scales of Rephotographing

Scale of Rephotography	Dimensions of Image Components, Microns	
	Δl_x	Δl_y
1:1	50	200
1:2	25	100
1:4	12.5	50
1:8	6.25	25

the maximum correlation peak was noted on the oscillograph screen. The measurements were made with displacements of the reference slide from 0 to 250 microns with spacing of 10 microns (the rate of oscillograph beam scanning was 0.5 ms/cm) and from 0 to 500 microns with spacing of 10 microns (the scanning rate was 1 ms/cm). The measurements were repeated three times on the average in each case.

Two situations were investigated: 1) the reference and signal slides were a fragment of the same image and 2) the reference and signal slides were fragments of images received from satellites on different days. To denote the first situation let us use the term "autocorrelation" and to denote the second situation let us use the term "cross-correlation."

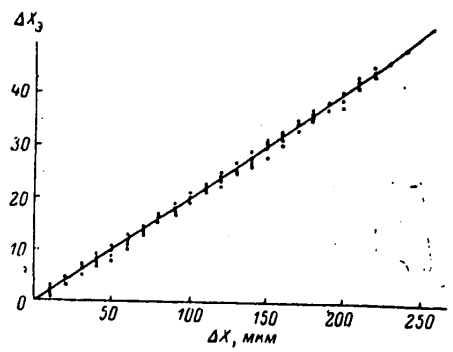

Figure 4. Dependence of Displacement of Maximum Correlation Peak ΔX_e on Displacement of Signal Slide ΔX

The dependence of the displacement of the maximum correlation peak ΔX_e (in units of the small divisions of the oscillograph screen) on the displacement of the reference slide ΔX is presented as an example for the case of autocorrelation in Figure 4. The image scale is 1:1. Similar functions were found for cases of auto- and cross-correlation for all four scales.

The results were processed on a computer and the measurements were approximated by a straight line [4] with respect to which the values of the mean square error σ and ratio $\Delta l_x/\sigma$--a dimensionless value that characterizes measurement accuracy (see Table 2), on the basis of the well-known least squares criterion.

Table 2. Mean Square Errors σ and Ratios $\Delta l_x/\sigma$ in Case of Auto- and Cross-Correlation for Different Scales at Two Values of Oscillograph Scanning Rate v

	v = 1 ms/cm				v = 1 ms/cm			
	Cross-correlation		Autocorrelation		Cross-correlation		Autocorrelation	
Scale	σ, micron	$\Delta l_x/\sigma$	σ, micron	$\Delta l_x/\sigma$	σ, micron	$\Delta l_x/\sigma$	σ, micron	$\Delta l_x/\sigma$
1:1	--	--	--	--	11.5	3.82	14.8	3.38
1:2	7.84	3.41	3.82	6.54	13.9	1.80	5.6	4.46
1:4	5.5	2.27	5.32	2.33	14	0.89	10.7	1.17
1:8	7.4	0.84	4.05	1.54	10.4	0.60	13.3	0.47

The individual values of the mean square errors vary over a rather wide range. Nevertheless the following conclusions can be made. First, no appreciable dependence on the image scale can be detected at all. Second, the mean value of the mean square error σ for six measurements made at scanning rate of 0.5 ms/cm (5.57 microns) is approximately one-half the corresponding value for eight measurements at scanning rate of 1 ms/cm (11.8 microns). Third, the mean values of the mean square errors in the case of cross-correlation, although few, are higher than in the case of autocorrelation (these values comprised 6.75 and 4.40 microns at scanning rate of 0.5 ms/cm and 12.45 and 11.1 microns at scanning rate of 1 ms/cm).

Detailed analysis of the experimental data showed that the accuracy of determining the displacement of the correlation maximum is limited by the operating instabilities of the correlator (specifically, the instabilities of the rotational speed of the hologram lens, synchronization of hologram lens rotation and scanning of the oscillograph beam) and by radio noise. It is obvious upon transition from scanning rate of 0.5 ms/cm to 1 ms/cm that errors related to rounding off the value of the coordinate of the correlation maximum with accuracy to the small division of the cathode-ray tube screen begin (one division corresponds to 5 microns on the input slide at scanning rate of 0.5 ms/cm and to 10 microns at scanning rate of 1 ms/cm). Due to the fact that scanning was accomplished within the dimensions of the reference fragment (a square with sides of 1.8 mm), the effect of aberrations of the optical system was probably insignificant.

As can be seen from Table 2, the value of the mean square error is hardly dependent on the image scale. Consequently, the relative accuracy of measuring the coordinates increases with an increase of image scale. For example, the value $\Delta l/\tau$ increased fourfold upon transition from a scale of 1:8 to one of 1:2 for the case of cross-correlation at scanning rate of 0.5 ms/cm.

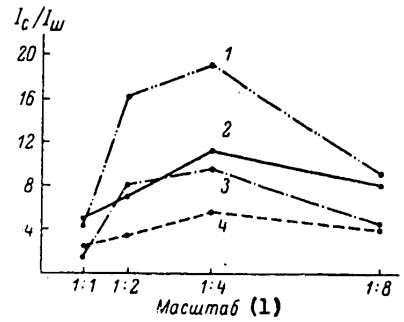

Figure 5. Dependence of Signal/Noise Ratio on Image Scale

Key:
1. Scale

It follows from consideration of Table 2 that the coordinates of fragments can be measured with an optical heterodyne correlator with an error considerably less than the dimensions of the input image resolving component. Of course, this result is achievable if the natural resolution of the correlator exceeds that in the image.

We note that similar results were found earlier with respect to a holographic correlator [3]. An approach was developed in [5] that permits one to give a natural explanation to the indicated results within the framework of already developed theory of signal separation on a background of additive Gauss noise.

The values of the signal/noise ratio for the cases of auto- and cross-correlation at four values of the scale (the analyzed fragments were selected on the same section of the photographs) are presented in Figure 5. Broken lines 1 and 2 join points that characterize the ratio $I_s/I_{sh.sr}$ for cases of auto- and cross-correlation, respectively. I_s is the value of the correlation maximum and $I_{sh.sr}$ is the mean value of noise within the oscillograms. Broken lines 3 and 4 connect points that characterize the ratio $I_s/I_{sh.max}$ for cases of auto- and cross-correlation and $I_{sh.max}$ is the value of the maximum noise ejection within the oscillogram. All four broken lines have minimum values at M 1:1, reach a maximum at M 1:4 and again decrease at M 1:8. As follows from the results, the optimum value with respect to the signal/noise ratio should be regarded as a scale of 1:4. An increase of the scale results in a decrease of this ratio due to constriction of the band of spatial signal frequencies effectively used by the correlator. A decrease of the scale to 1:8 also causes a decrease of the signal/noise ratio, this time because of losses of image information content that arise upon rephotography on this scale.

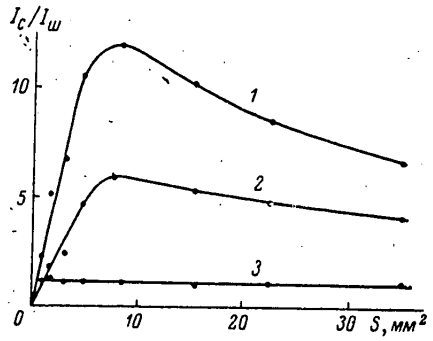

Figure 6. Dependence of Signal/Noise Ratio on Area of Fragment of Reference Slide S

The dependence of ratios $I_s/I_{sh.sr}$ (1) and $I_s/I_{sh.max}$ (2) on the area of the slide fragment for the case of cross-correlation, M 1:4, are presented in Figure 6. Curves 1 and 2 reach a maximum with area of the fragment of the reference slide on the order of 8 mm^2. The value of the signal/noise ratio then begins to drop, which may be explained by the fact that the effect of aberration and phase errors between the signal and reference images at the output of the optical system of the correlator, introduced by the Fourier transform lens, the collimator, the holographic lens and also by phase inhomogeneities of the slide substrates, increases as the aperture increases. The dependence of the ratio $I_{sh.max}/I'_{sh.max}$ on the area of the fragment of reference slide (3), where $I'_{sh.max}$ is the value of the noise discharge on the oscillogram that follows as a maximum value, is shown in this same figure. This ratio hardly differs from 1. Therefore, a simple algorithm, according to which the values of two maximum blips on the oscillogram must be measured and the

ratio must be determined. If both blips are of noise origin, the ratio is on the order of 1. If the ratio significantly exceeds 1 (on the order of 5-7 in our case), then the highest ratio can be related to an identified fragment.

It should be emphasized that the correlation function module rather than its square is measured with the optical heterodyne correlator, as in the case of a holographic correlator. Therefore, the values of the signal/noise ratio equal to 5-7 are equivalent to values of signal/noise ratio equal to 25-49 in the case of a holographic correlator.

The effect of installing an optimizing amplitude space filter (OF) in the second frequency plane was studied during the investigations. A finished filter previously obtained for several different images was used as the OF; consequently, this filter was not optimum in the total sense. Nevertheless it turned out that the signal/noise ratio improved by a factor of 1.5-2 when the given filter was installed, whereas the ratio $I_{sh.max}/I'_{sh.max}$ decreased on the average from 1.31 to 1.16. The results confirm the usefulness of using OF specially manufactured for the given type of images.

Let us dwell on the results of investigating the dependence of the correlation maximum on the angle of rotation of the reference slide with respect to optimum orientation. This problem is primarily of interest from the viewpoint of requirements on the accuracy of installing the fragments to be analyzed by angle.

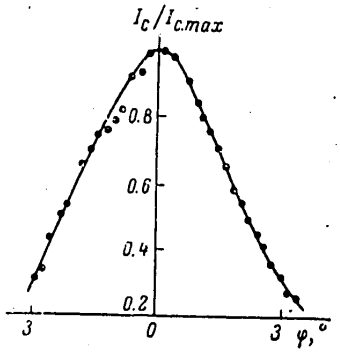

Figure 7. Dependence of Correlation Signal (in relative units) on Angle of Rotation ϕ of Reference Slide

The angular dependence of the correlation maximum (in relative units) is shown in Figure 7 for the case of autocorrelation and image scale of 1:2. The curve reaches a maximum at angle equal to zero and drops one-half at angles of rotation $\phi_{0.5}$ of approximately $\pm$ 2°. It must be noted that the separate curves found in different scales are characterized by rather large variety of values of angles $\phi_{0.5}$: from 1.5 to 4°. The main reason for this variability consists in the fact that, on the one hand, individual image fragments differ significantly from the viewpoint of informative parts in them and on the other hand it was difficult to join the center of rotation to the center of the fragment being analyzed and as a result the fragment not only rotates but is shifted along the Y axis, which leads to a more rapid

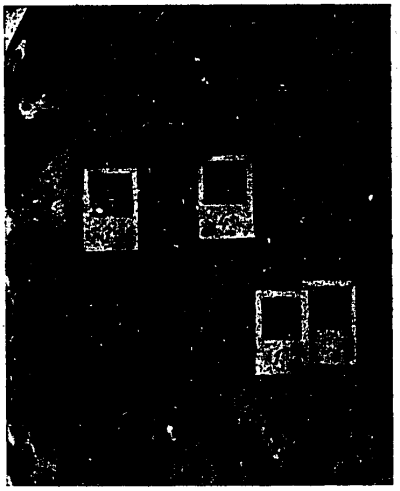

Figure 8. Photograph Taken From Satellite on 22 July 1975 (negative)

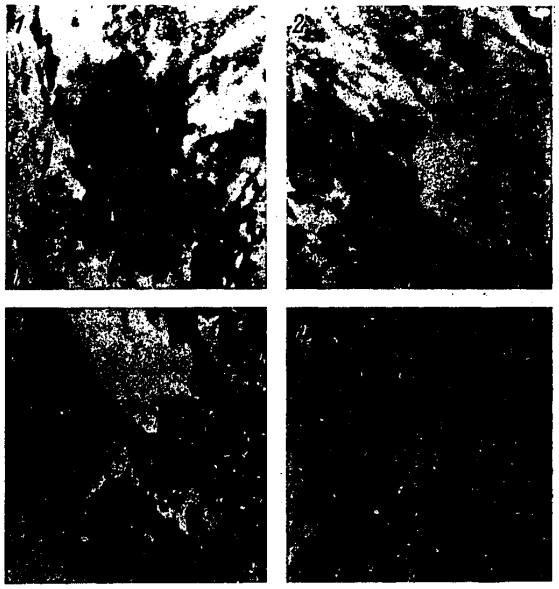

Figure 9. Enlarged Photograph of Four Sections (negative)

decrease of the correlation maximum compared to the case when this shift is absent. On the whole the values of angles $\phi_{0.5}$ correspond to those which should be expected. In the general case the value of $\phi_{0.5}$ should decrease as the area of the fragment increases, i.e., the critical orientation of the fragment will increase.

2. Investigating Correlation Identification of Picture Fragments of Cloud Formations

Three photographs transmitted from a geosynchronous satellite on 22 July 1975: one at 2115, two at 2145 and three at 2245 Greenwich time, were used in the experimental investigations. The coordinates of the point under the satellite were 0° latitude and 115° west longitude. The image component had the shape of a square with side of 50 microns, which corresponded to a square with side of 3.6 km on the earth's surface. The investigations were conducted both in the autocorrelation mode when sections of image 2 were used as the signal and reference slides and in the cross-correlation mode when sections of images 1 and 2 (at time interval of 30 minutes) were used. Moreover, single experiments of images 2 and 3 (at interval of 60 minutes) were conducted in the cross-correlation mode.

A photograph which is one-fourth of the total image 2 obtained from a geosynchronous satellite is presented as an example in Figure 8. Four sections (denoted by the numbers in the figure) were selected in the photographs being analyzed. The fragments were subjected to correlation processing when conducting the given investigation. Magnified images of the indicated sections with the following types of overcast are presented in Figure 9: cirrus 1, cumulus and stratocumulus 2, cumulus 3 and cumulus with closed cells 4.

As when processing the images of the earth's surface, the sections to be analyzed were rephotographed on Mikrat-300 film, as when processing images of the earth's surface. To select the most optimum information recording density, the rephotographing was carried out both with variation of scale and with reduction of it by a factor of 2, 4, 6 and 8. The functions for the signal to maximum noise blip ratio $I_S/I_{sh.max}$ for auto- and cross-correlation at five values of scale are presented in Figure 10. Broken lines 1 and 2 connect the points that characterize the signal/noise ratio for the case of auto-correlation of image fragments belonging to sections 2 and 1, respectively. Broken lines 3 and 4 correspond to cross-correlation of fragments of the same image sections (the fragment of the same name had the shape of a square with side of 2 mm). As follows from the results, the highest values of the signal/noise ratio are reached at a scale of 1:4; therefore, subsequent investigation was conducted with images of this very scale.

The accuracy of determining the displacements of the picture fragments belonging to the four selected sections was then estimated. The values of the mean square errors σ and ratios $\Delta l/\sigma$ are presented in Table 3. As can be seen from the table, the displacements of the cloud formations can also be measured in the case of images of cloud cover with error much less than the resolution. The maximum measurement accuracy is determined by the design of the correlator and optical and electronic noise.

The accuracy of measurements in the cross-correlation mode was then estimated for image fragments obtained at time interval of 60 minutes. On the whole the signal/noise ratio decreases one-half in this case while the value of the mean square

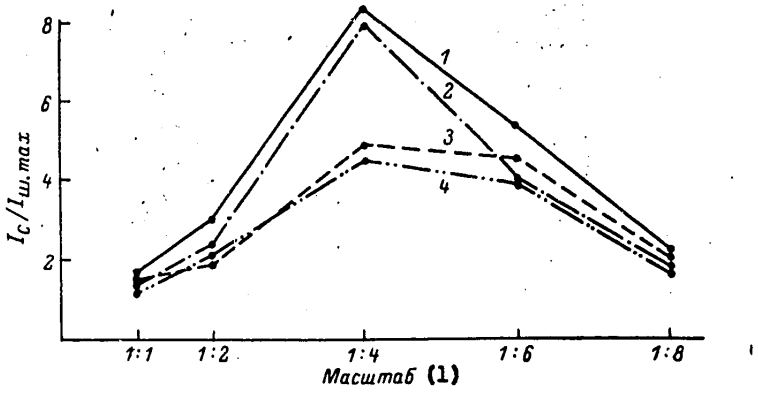

Figure 10. Dependence of Ratio $I_s/I_{sh.max}$ on Image Scale

Key:
1. Scale

Table 3.

Number of Section	Autocorrelation		Cross-correlation, interval of 30 min		Cross-correlation, interval of 60 min	
	σ, micron	Δl/σ	σ, micron	Δl/σ	σ, micron	Δl/σ
1	4.2	2.98	7.3	1.71	3.7	3.4
2	7.2	1.74	4.4	2.84	--	--
3	5.8	2.16	7.7	1.62	--	--
4	3.8	3.29	4.6	2.72	5.3	2.36

error σ and ratio Δl/σ is approximately the same as in the case of cross-correlation of image fragments obtained at interval of 30 minutes.

The dependence of the signal/noise ratio on the area of the identified fragment S is presented in Figure 11 for all four sections (image scale of 1:4). Curves 1 on each of three graphs a-d characterize the ratio $I_s/I_{sh.max}$ for the case of autocorrelation and curves 2 characterize the same ratio for cross-correlation. Curves 3 characterize the ratio of maximum noise blip to the next noise blip $I_{sh.max}/I'_{sh.max}$. As one would expect, the ratio $I_s/I_{sh.max}$ is higher in the case of autocorrelation (curves 1) than for cross-correlation (curves 2). It is typical for all graphs that the maximum values of curves 1 and 2 occur on areas of identified fragments less than 10 mm^2 which generally corresponds to the results obtained in experiments on identification of fragments of the underlying surface.

The values of the areas of identified fragments at which the curves are maximum depend on the information properties of specific fragments and vary randomly. These curves can sometimes have two maximums, which is explained by inclusion of new cloud formations in the boundaries of a fragment as its area increases.

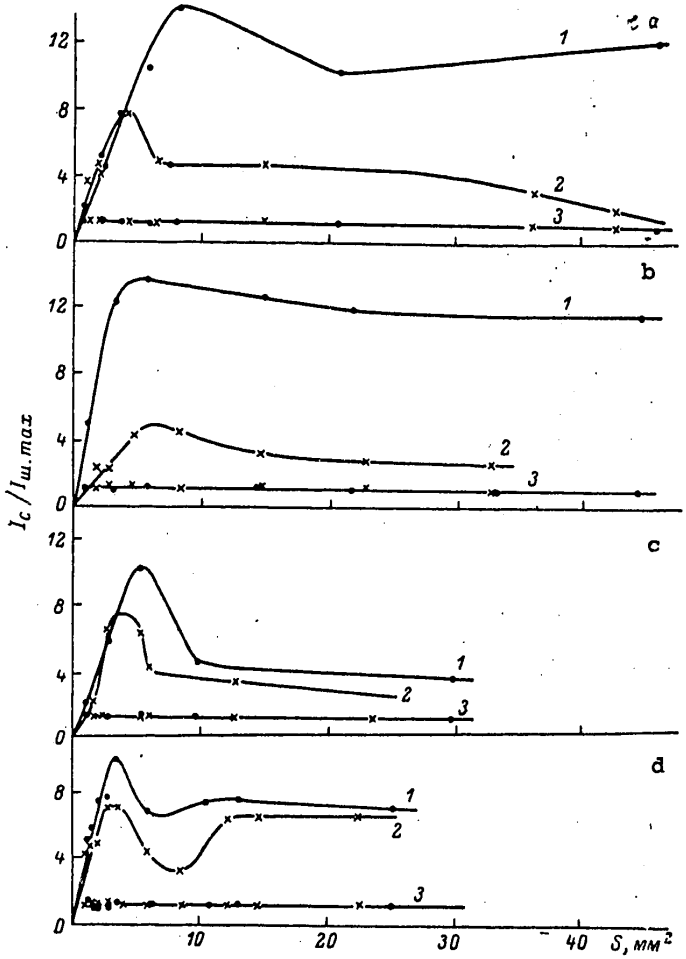

Figure 11. Dependence of Signal/Noise Ratio on Area of Identified Fragment S

Finally, it should be emphasized that whereas the signal/noise ratio is practically always higher than 5, the ratio $I_{sh.max}/I'_{sh.max}$ remains in the range of 1-1.5 (curves 3). This result permits one to talk about the applicability of a simple identification algorithm consisting in measuring the amplitudes of the two greatest surges of the oscillogram and comparison of their ratio to a threshold value equal to 2-3. Since cloud formations generally move along curvilinear trajectories, the angular dependence of the identification signal must also be taken into account.

The dependence of the cross-correlation maximum on the angle of rotation of the reference for section 4 is presented in Figure 12.

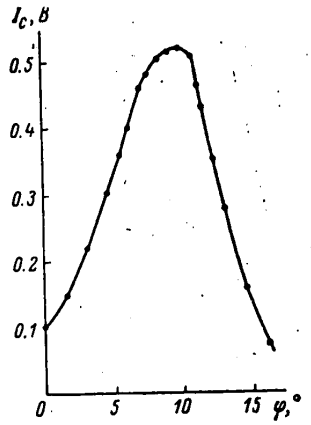

Figure 12. Dependence of Correlation Maximum on Oscillograph Screen I_S on Angle of Rotation of Reference Slide ϕ

The angular dependence of the cloud formation identification signal together with data on linear motions permits one to follow the variation of the total velocity vector by finding the maximum correlation signal.

Conclusions

The estimates of the accuracy of measuring the displacements and angles of rotation of the fragments of space photographs of the earth's surface and cloud formations obtained in the given paper by correlation comparison with references in an OGK indicate the applicability of this method for solving different problems of space video information processing. It is significant in this case that processing the images in an OGK does not require manufacture of holographic filters, which permits comparatively easy use of it in the optical-electronic operational information processing complex. If the scale of the input slides is properly selected and if the device is executed with high quality, the error of measuring the displacement of the identified fragment is less than the dimension of resolution in the image.

The results of the experiments demonstrate the possibility of correlation identification of fragments of space photographs of the earth's surface by means of a simple algorithm consisting in separation of the two highest correlation signals, calculation of their ratio and comparison of it to some threshold value determined upon study. However, a preliminary rough correction of the projective geometric distortions in space photographs is required for successful realization of this algorithm, which can be accomplished by electronic systems during preliminary recording. Further investigations must be conducted toward improving the OGK schemes for given application and accumulation of statistical data on identification of fragments from a large file of space photographs of different types to refine the requirements on the image quality and to create a set of optimum filters for different types of images.

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ACOUSTOOPTICAL PROPERTIES OF INFORMATION PROCESSING BASED ON NONLINEAR ACOUSTICAL INTERACTION

Leningrad RADIOGOLOGRAFIYA I OPTICHESKAYA OBRABOTKA INFORMATSII V MIKROVOLNOVOY TEKHNIKE in Russian 1980 (signed to press 24 Oct 80) pp 155-163

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[Text] A number of acoustooptical devices for processing optical and radio signals has recently been developed, for example, on the basis of colinear acoustooptical interaction, multibackground bragg scattering of light and so on. Along with this investigations of yet another new class of devices are being conducted which utilize nonlinear interaction of elastic waves. Development of these devices was determined by the appearance of materials with high coefficient of acoustooptical quality and high elastic nonlinearity.

The results of experimental investigation of a number of acoustooptical devices based on colinear nonlinear interaction of volumetric elastic waves are presented in the article.

1. The operating principle of nonlinear acoustooptical devices (ANU) is based on scattering of a luminous flux impinging on a sound conductor on an elastic wave generated by two initial elastic waves propagated in a medium with elastic nonlinearity. Let us consider in more detail the case of colinear interaction of elastic waves during propagation along an acoustic axis.

As is known, in this case one of the elastic waves is longitudinal and two others are transverse. The two waves 1 and 2 excited in the sound conductor generate a third wave 3 upon interaction if the conditions of synchronism are fulfilled

$$f_1 \pm f_2 = f_3, \quad K_1 + K_2 = K_3, \tag{1}$$

where f_i and K_i are the frequency and wave vector of the i-th wave. If condition (1) is fulfilled, eight types of interactions are possible [1] which have permutational symmetry in the sense that the two longitudinally selected waves interact and generate a third wave.

One can show that in the absence of attenuation ($\alpha_i = 0$), the outputs P_i of parametrically related elastic waves are determined by elliptical Jacobean functions.

$$P_1(x) = P_1(0)\, dn^2 \xi x, \tag{2a}$$

$$P_2(x) = \frac{f_2}{f_1} P_1(0)\, k^2 cn^2 \xi x, \tag{2b}$$

$$P_3(x) = \frac{f_3}{f_1} P_1(0)\, k^2 sn^2 \xi x, \tag{2c}$$

where

$$k^2 = \frac{f_1 P_2(0)}{f_2 P_1(0)}, \quad \xi = \frac{\Gamma}{4}\left(\frac{8\pi^2 P_1(0) f_2 f_3}{\rho S V_1^3 V_2 V_3}\right)^{1/2},$$

Γ is a parameter of nonlinearity, ρ is the density of the sound conducting material, $P_1(0)$ and $P_2(0)$ are the outputs of the initial waves, S is the cross-section of the acoustic column and x is the current coordinate. From (2c) at small values of ξx we find

$$U_3(x) = \frac{\Gamma}{4} K_1 K_2 U_1(0)\, U_2(0)\, x, \tag{3}$$

where $U_i(x)$ is the amplitude of the i-th wave. If attenuation ($\alpha_i \neq 0$) is taken into account, coordinate x in (3) must be replaced by x_{ef}:

$$x_{эф} = \frac{\exp(-\alpha_3 x) - \exp[-(\alpha_1 + \alpha_2)x]}{\alpha_1 + \alpha_2 - \alpha_3}. \tag{4}$$

Relations (3) and (4) permit one to determine the amplitude of the generated elastic wave.

If the initial waves U_1 and U_2 are pulsed signals whose length is short compared to the travel time of elastic waves through the sound conductor, then amplitude U_3 is determined by the formula

$$U_3(t) = \frac{\Gamma}{4} K_1 K_2 \int_{-\infty}^{\infty} U_1(t \pm \tau)\, U_2(\tau)\, d\tau, \tag{5}$$

i.e., it has an integral of the correlation or convolution type.

It is obvious from relations (3)-(5) that ANU permit one to realize the shift of two signals, their correlation and convolution, and also the controlled delay of a radio signal with simultaneous introduction of the received information into an optical system for further processing.

2. Typical for an ANU is the need to develop sufficient output density of elastic waves that, as can be seen from (2) and (5), permits one to increase the efficiency

of the device and also to operate in a wide frequency band which is determined upon fulfillment of conditions (1) only by the piezotransducer band. This circumstance determines a number of characteristics in manufacture of acoustooptical cells for ANU.

It is known that the amplitude and frequency characteristics of acoustooptical cells are considerably dependent on the method of attaching the piezotransducer to the sound conductor. As shown by calculations [2], the highest working frequency bands are realized when the transducer is attached to the sound conductor by metal binding layers. The cells used in the given paper were manufactured by a specially developed technique and the transducers were attached by the thermocompression method by copper-indium binding layers [3].

The process of manufacturing the acoustooptical cells reduced to the following main operations.

Sound conductors of $PbMoO_4$ and GaP and transducer plates of $LiNbO_3$ were initially machined by optical grinding and polishing methods. In this case the nonparallellism of the transducers and edges of the sound conductors to which the transducers were attached did not exceed 1 micron. After chemical cleaning in toluene and isopropyl alcohol, layers of metals that served as the binding layer in attachment of the transducers to the sound conductors and also as one of the transducer electrodes were applied to one of the ends of the sound conductor and to one of the sides of the transducer by the thermal vacuum spraying method. Moreover, in our case sublayers of chromium that ensure adhesion of the subsequent metal layers, copper and then indium, were sprayed on. Spraying the copper improved the conductivity of the binder layer at high frequencies. The thickness of the sprayed copper and indium layers was such that an approximate weight ratio of 60 percent copper and 40 percent indium was provided and in this case the thickness of the indium layer was approximately equal to one-fourth the wavelength of ultrasound in indium on the central modulator frequency. The transducer plate was then attached to the sound conductor by the thermocompression method. It should be noted that the piezotransducers were attached to opposite ends of the sound conductors simultaneously. Moreover, the ends of the sound conductors to which the transducers were attached were not polished to improve adhesion during manufacture of lead molybdate modulators.

The thickness of the piezotransducer was then brought up to the required thickness equal to half the elastic wavelength in the transducer material with regard to the electromechanical coupling coefficient. The process of manufacturing the acoustooptical cell was completed by vacuum spraying of an upper electrode (Ti, Cu and In). The manufactured cell was attached to a special support after which the transducer electrodes were soldered through the transition contact surface to the contact of a high-frequency plug.

The conversion losses measured by the echo pulse method comprised approximately 3-5 dB per conversion for longitudinal waves and approximately 5-6 dB for shear waves with regard to diffraction and dissipative losses. The working frequency band of these cells was equal to 30-40 percent with electric matching of the impedance of the transducer and power supply circuits.

3. Let us dwell further on the results of experimental investigations that we conducted on an ANU based on acoustical collinear interaction in lead molybdate and gallium phosphide crystals.

a. Lead molybdate crystal mixer. Lead molybdate has the highest elastic nonlinearity for longitudinal acoustic waves propagated along a fourth-order axis in one direction. The variance diagram for degenerate colinear interaction of longitudinal waves is presented in Figure 1. The laws of conservation of energy and pulse (1) are identically fulfilled in this case and consequently mixing will occur for any pairs of initial wave frequencies. For the selected configuration of interaction the parameter of nonlinearity is equal to [1].

$$|\Gamma| = \left|3 + \frac{C_{333}}{C_{33}}\right| = 17.5.$$

The sound conductor had dimensions of 8 X 9 X 23 mm with longest length along the [001] axis. The piezotransducer operated on frequencies from 80 to 350 MHz and ensured acoustic output density up to 5 W/cm^2 (the dimensions of the upper electrode were 1.2 X 5 mm).

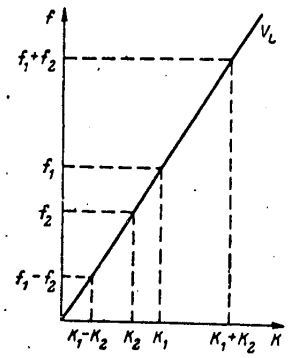

Figure 1. Variance Diagram for Degenerate Collinear Nonlinear Interaction of Longitudinal Elastic Waves

Mixing was investigated on the following frequency pairs f_1 and f_2: 80 and 320, 115 and 320, 150 and 320 and 320 and 320 MHz in the continuous mode using modulation of one of the input signals with frequency meander of 1 kHz. A photodetector recorded the light intensity I_3 scattered on the generated wave with frequency f_3. The dependence of intensity I_3 on the length of interaction of initial waves x is presented in Figure 2 for different levels of input power P. The contributions of sequential scattering, the nonlinearity of the piezotransducer and spurious harmonics of SHF generators which did not exceed several percent were subtracted when plotting the experimental curves. The extreme nature of the curves was determined by the presence of elastic wave attenuation.

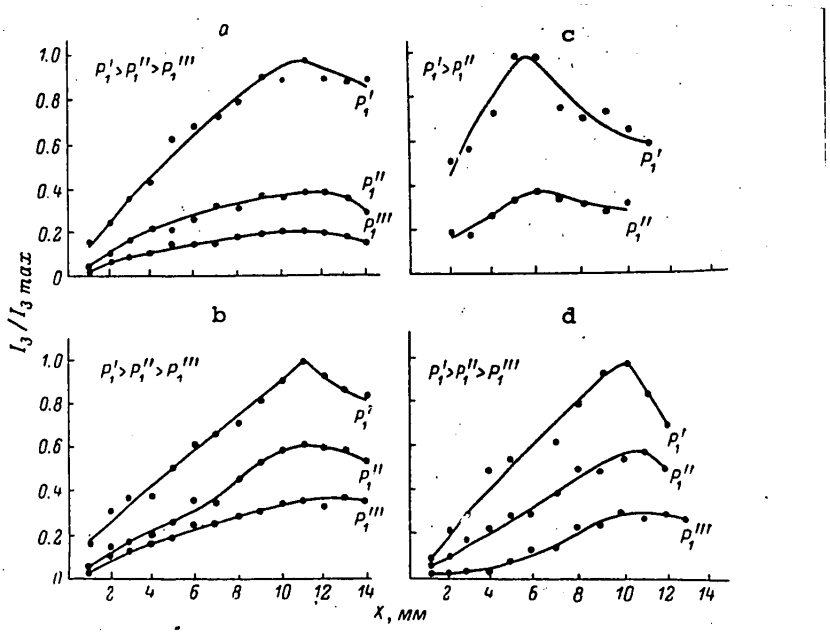

Figure 2. Dependence of Scattered Light Intensity I_3 on Length of Interaction X of Initial Waves for Different Levels of Input Power P: f_1 = = 320 MHz, a--f_2 = 150 MHz and $f_1 + f_2 = f_3$ = 470 MHz; b--f_2 = 115 MHz and $f_3 = f_1 + f_2$ = 435 MHz; c--f_2 = 80 MHz and $f_3 = f_1 - f_2$ = = 240 MHz; d--f_2 = 320 MHz and $f_3 = f_1 + f_2$ = 640 MHz

For quantitative analysis of the mixer parameters, let us select for example the case of mixing of frequencies f_1 = 320 MHz, f_2 = 115 MHz and $f_3 = f_1 + f_2$ = 435 MHz. In the case when acoustic output of initial waves comprises $P_1 \approx P_2 \approx$ 100 mW, we find from (3) and (4) $P_3 \approx 5$ mW, i.e., the relative efficiency of the acoustic mixer is equal to $P_3/P_1 + P_2 \approx 2.5$ percent. The effectiveness of light scattering on the acoustic wave f_3 comprises approximately 1 percent, which is in good agreement with the experimental analysis. As can be seen from Figure 2, effective mixing is observed over a wide frequency band which is limited only by the piezotransducer bandpass. In this case the effectiveness of mixing increases with an increase of input signal power and frequency, whereas there is an optimum length of initial wave interaction due to attenuation.

b. A gallium phosphide crystal correlator. Nondegenerate interaction of acoustic waves propagated in opposite directions along the [111] axis of a GaP crystal (class $4\bar{3}$ m) was used to develop this device. The variance diagram for this case is presented in Figure 3 and the laws of conservation (1) have the form

$$f_{L_1} - f_{S_2} = f_{S_3}, \quad K_{L_1} - K_{S_2} = K_{S_3}. \tag{6}$$

A shear wave S_3 propagated in the same direction with the initial longitudinal wave is generated as a result of interaction of the longitudinal L_1 and shear S_2 waves.

The ratio between the initial wave frequencies follows from (6) with different polarization waves participating in the interaction

$$\frac{f_2}{f_1}=\frac{2V_L}{V_L-V_S}, \tag{7}$$

and the generated wave frequency is also determined

$$f_3=\frac{f_1(V_L+V_S)}{2V_L}=\frac{f_2(V_L+V_S)}{V_L-V_S}. \tag{8}$$

Relation (5) with regard to the velocity sign has the form

$$U_3(t)\sim\Gamma K_1K_2V_S\int_{-\infty}^{\infty}U_1(\tau')\,U_2(\tau)\,d\tau, \tag{9}$$

where

$$\tau=t+\frac{2x}{V_S}-\frac{x_0}{V_S},\quad \tau'=\alpha(t+\Delta t)+\beta\tau;$$

x_0 is the coordinate of the point for tapping the signal with a laser beam. Consequently (9) is a correlation integral with parameters: $\alpha = (V_L + V_S)/2V_L$ is the time scale factor, $\Delta t = -x_0/V_S$ is the time shift factor and $\beta = (V_L - V_S)/2V_L$ is the amplitude scale factor.

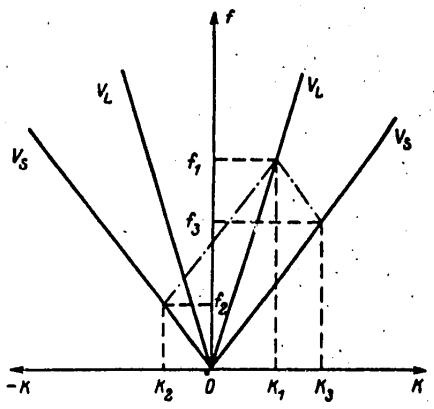

Figure 3. Variance Diagram for Nondegenerate Collinear Nonlinear Interaction of Elastic Waves

Experimental investigation of the operation of the correlator was conducted at initial signal frequencies $f_{L_1} \approx 440$ MHz and $f_{S_3} \approx 90$ MHz with generated wave

frequency of $f_{S_3} \approx 350$ MHz. In this case the scale factors are equal to $\alpha = 0.79$, $\beta = 0.21$ and $|\Delta t| = 5.7$ microseconds ($x_0 = 2.15$ cm).

Initial wave pulses $\tau_1 = 2.0$ microseconds and $\tau_2 = 3.0$ microseconds were propagated counter to each other at velocities $V_L = 6.45 \cdot 10^5$ cm/s and $V_S = 3.76 \cdot 10^5$ cm/s in a GaP crystal 55 mm long. The acoustic pulse lengths were approximately identical. The acoustic output densities created by the piezotransducers reached 5 W/cm^2 with dimension of the upper electrode of 1.2 X 6 mm.

An optical diagram of light scattering on the generated wave is presented in Figure 4. The bragg mode of light scattering was realized since the diffraction parameter Q exceeded the value Q = 10. The point of impingement of the light beam on the crystal was selected so that the acoustic pulse with frequency f_2 intersected it first. After this pulse f_2 and pulse f_1 delayed by $t_{zad} = 11$ microseconds, interact to the left of the optical beam and generate an acoustic pulse with frequency f_3 which is propagated to the right at velocity V_S and intersects the optical beam. The oscillograms of the input pulses and the correlation signal are presented in Figure 5. The length of the correlation signal is equal to $\tau \approx 2$ microseconds by the level of half power. The maximum signal is recorded at moment of time $t \approx 16$ microseconds with respect to the moment the input pulse of shear wave with frequency f_2 is started. The effectiveness of light scattering on the generated wave comprised 10^{-2} to 10^{-3}. The values of the nonlinearity parameter Γ, whose analytical expression for the used configuration of interaction has the following form, were analyzed on this basis

$$\Gamma = 1 + \frac{3C_{355(p\phi)}}{C_{11} + 2C_{12} + 4C_{44}}.$$

A value of $|\Gamma| \approx 6$ was found for Γ.

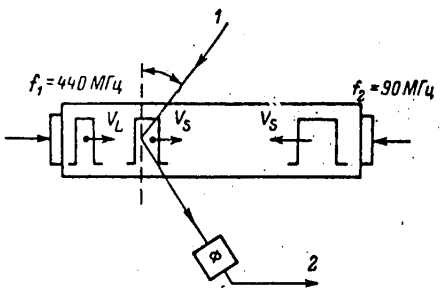

Figure 4. Optical Diagram of Light Scattering on Wave Generated in ANU Cell Based on Gallium Phosphide: F--photodetector; 1--impinging light; 2--to amplifier

4. The given consideration of acoustooptical devices based on collinear nonlinear direction of acoustic waves indicates the possibility of developing these devices, which have the special main characteristics:

the radio signals are processed in real time over a wide frequency band determined only by the piezotransducer band when phase synchronism conditions are fulfilled;

the efficiency of these devices is no less than that of most devices now used and increases with an increase of working frequencies, which is very promising from the viewpoint of developing devices that operate at hypersonic frequencies;

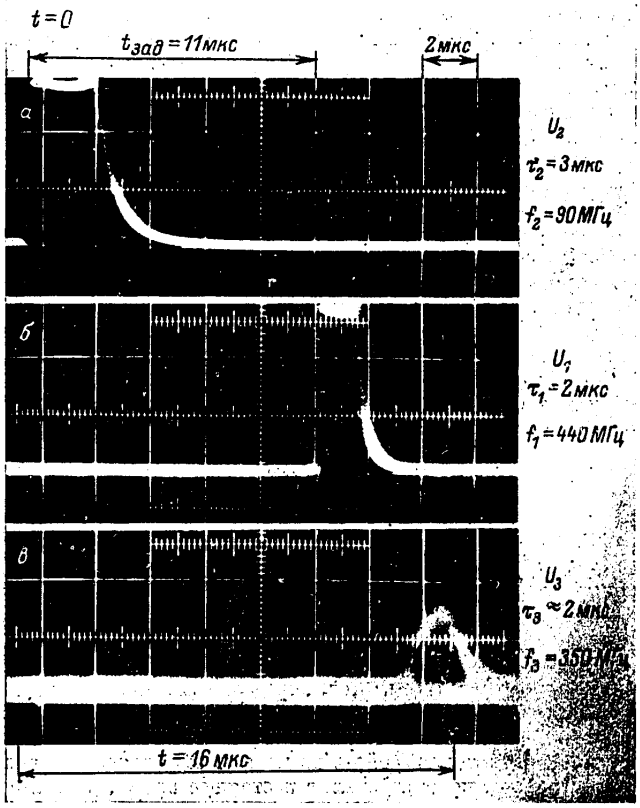

Figure 5. Oscillograms of Input Pulses (a, b) and Correlation Signal (c)

the use of nonlinear acoustical interaction does not deteriorate the dynamic range of optical information processing systems since the dynamic range of acoustic processes themselves, determined by very weak thermal noise in a solid, comprise approximately 90 dB [1];

the generated acoustic signal is read by an unsplit light beam or a beam focussed at the point of tapping; consequently, the aperture of the first lens in the optical system of the ANU is small and is not dependent on the dimensions of the sound conductor, whereas ordinary acoustooptical devices require a collimating system with lenses whose dimensions exceed those of the sound conductor;

the use of an ANU makes it possible to simplify the arrangement of the processing system for achieving convolution or correlation of signals compared to acoustooptical devices ordinarily used;

universal materials now used, for example, such as lead molybdate, gallium phosphite, paratellurite and so on, can be investigated for development of ANU.

The indicated characteristics permit one to conclude that acoustooptical devices based on collinear nonlinear acoustic interaction will find their place in a number of radio signal processing devices.

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EFFECT OF ELASTIC WAVE ATTENUATION ON OUTPUT SIGNAL OF ACOUSTOOPTICAL DEVICE FOR CORRELATION ANALYSIS

Leningrad RADIOGOLOGRAFIYA I OPTICHESKAYA OBRABOTKA INFORMATSII V MIKROVOLNOVOY TEKHNIKE in Russian 1980 (signed to press 24 Oct 80) pp 163-174

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[Text] Introduction

The concept of functional space L_{2E} [1, 2] is used extensively in the theory of analog devices for processing continuous causal signals with limited energy. Its application specifically permits one to select the criterion of comparison (the measure of proximity) of signals shaped by real devices (real signals) and the signals of ideal devices (ideal signals).

This criterion can be used to analyze linear distortions of signals in acoustooptical devices. They may include distortions determined by attenuation of high-frequency elastic waves in an acoustooptical interaction medium at low levels of input signals.

These distortions of signals in an acoustic light modulator (AMS) and of output signals of correlation analysis acoustooptic devices (AOUKA) are considered in this paper.

Let us limit ourselves to the case of relatively narrowband signals, practically complete information about which is contained in their complex envelope.

Let us use as a measure of proximity of real and ideal signals normalized Euclidean metrics [3] determined by the relation

$$\frac{\Delta_E}{\Delta_{E\max}} = \frac{\|C_{\text{ид}} - C\|}{\|C_{\text{ид}}\| + \|C\|}, \qquad (1)$$

where $\| \ \|$ is a sign of the norm and $C_{id} = C_{id}(x, y)$ and $C = C(x, y)$ are the moduli of the complex envelopes of ideal and real signals. We note that the value $\Delta E/\Delta E_{max}$ corresponds to the normalized mean square error.

The Signal in the AMS

It has been accepted to characterize attenuation of elastic waves in an acoustooptical interaction medium by frequency-dependent coefficient $\alpha(\omega)$. It is specifically taken into account in the electroacoustical transfer coefficient of the AMS introduced in [4, 5]. This coefficient characterizes the frequency properties of the AMS and establishes the clear relationship between the spectrum of the input electric signal and the instantaneous spectrum of the spatial frequencies of an elastic wave packet (space-time signal) in the modulator aperture.

Relations that determine the signal shape must be found to estimate the distortions in the AMS.

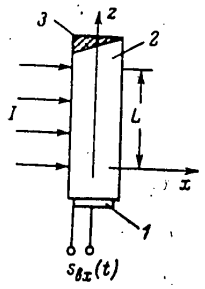

Figure 1. Acoustic Light Modulator: I--plane light wave; L--length of aperture along direction of elastic wave propagation; 1--piezotransducer; 2--light-sound conductor; 3--acoustic absorber

Let us assume that the AMS aperture (Figure 1) is sufficiently large (greater than the length of the elastic wave packet). The space-time signal in this aperture, corresponding to the input electric signal s(t), can then be represented in the following form:

$$r(z)\, s(vt,\ z) = \frac{r(z)}{2\pi} \int_{-\infty}^{+\infty} \dot{S}(\omega_z)\, \dot{K}(\omega_z,\ z)\, e^{-j\omega_z(vt-z)} d\omega_z, \qquad (2)$$

where $\dot{K}(\omega_z, z)$ is the electroacoustical transmission coefficient of the AMS [4, 5], $\dot{S}(\omega_z)$ is the signal spectrum s(t) expressed in spatial frequencies ω_z, v is the speed of propagation of elastic waves, z is a spatial coordinate

$$r(z) = \begin{cases} 1 & \text{at } v(t-t_u) \leqslant z \leqslant vt, \\ 0 & \text{at } z > vt \end{cases} \qquad \text{and} \quad z < v(t-t_u), \qquad (2)$$

is the sign of complex conjugation. In this case

$$\dot{K}_{\text{п}}(\omega_z,\ z) = e^{-\alpha(\omega_z)z} \cdot \dot{K}_{\text{п}}(\omega_z), \tag{3}$$

where $\dot{K}_p\ (\omega_z)$ is the transmission coefficient of an electroacoustic (piezoelectric) transducer expressed in spatial frequencies.

Let us go on in (2) to time frequencies. Then

$$r(z)\, s(vt,\ z) = \frac{r(z)}{2\pi v} \int_{-\infty}^{+\infty} e^{-\alpha(\omega)z} \dot{S}(\omega)\, \dot{K}_{\text{п}}(\omega)\, e^{j\frac{\omega}{v}(vt-z)} d\omega. \tag{4}$$

Let us assume that

$$K_{\text{п}}(\omega) = \begin{cases} K_0 & \text{at } \omega_0 - \Delta\omega_0 \leqslant \omega \leqslant \omega_0 + \Delta\omega_0, \\ 0 & \text{at } \omega > \omega_0 + \Delta\omega_0 \end{cases} \qquad \text{and} \quad \omega < \omega_0 - \Delta\omega_0, \tag{5}$$

where ω_0 is the mean bandpass frequency of the AMS usually coincident with the signal carrier frequency s(t) and $2\Delta\omega_0$ is the width of the AMS bandpass.

Moreover, the signal delay time in the piezotransducer of the AMS is negligible due to its smallness while we subsequently omit the multiplier r(z).

The following analytical signal will then correspond to signal (4)

$$s'(vt,\ z) = \frac{K_0}{\pi v} \int_{\omega_0-\Delta\omega_0}^{\omega_0+\Delta\omega_0} e^{-\alpha(\omega)z} \dot{S}(\omega)\, e^{j\frac{\omega}{v}(vt-z)} d\omega, \tag{6}$$

which can also be represented in the following form

$$s'(vt,\ z) = \dot{C}(vt,\ z)\, e^{j\frac{\omega_0}{v}(vt-z)}, \tag{7}$$

where

$$\dot{C}(vt,\ z) = \frac{K_0}{\pi v} \int_{-\Delta\omega_0}^{+\Delta\omega_0} e^{-\alpha(\omega_0-\Omega)z} \dot{S}(\omega_0 - \Omega)\, e^{-j\frac{\Omega}{v}(vt-z)} d\Omega \tag{8}$$

is the complex envelope. In this case

$$\dot{C}(vt,\ z) = C(vt,\ z)\, e^{j\varphi(vt,\ z)}. \tag{9}$$

The results of numerous investigations of materials which find application for development of various acoustooptical devices [5-8] can be used for practical calculations of the signal shape in the AMS. These experimental data indicate that the

the the quadratic dependence of the attenuation coefficient on frequency is most frequently countered, which is typical for most crystals and glass over a wide frequency and temperature range. Therefore, let us limit ourselves in this paper to consideration of the function $\alpha(\omega) = \Gamma_2\omega^2$, where Γ_2 is the dimensional proportionality constant.

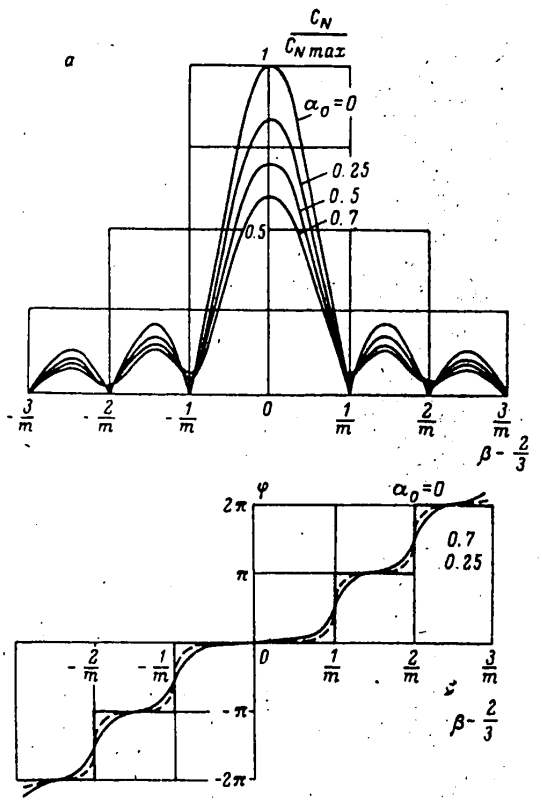

Figure 2. Signal at AMS Aperture at $s(t)=\frac{\sin\Delta\omega_0 t}{\Delta\omega_0 t}\cos\omega_0 t$. : a--modulus of complex envelope; b--phase characteristic

Let us introduce the following AMS parameters:
$a = \Omega/\omega_0$ is the relative detuning, $\alpha_0 = \Delta\omega_0/\omega_0$ is the relative detuning corresponding to the boundary frequencies of the AMS bandpass, $\beta = z/L$ is a dimensionless spatial coordinate, $t' = tv/L$ is dimensionless time; $\alpha_0 = \Gamma_2\omega_0^2 L$ is attentuation of the harmonic oscillation of the carrier frequency on length L, $T = L/v$ is the travel time of the elastic wave packet through the AMS aperture and $m = 2\Delta f_0 T$ is the information capacity of the AMS, greater than or equal to the information capacity of the signal at the input.

With regard to the parameters, let us write (8) in the following manner:

$$\dot{C}(t',\beta) = \frac{K_0\dot{\omega}_0}{\pi v}\int_{-a_0}^{+a_0} e^{-\alpha_0\beta(1-a)^2}\dot{S}(a)\,e^{-j\frac{\pi m a}{a_0}(t'-\beta)}\,da. \qquad (10)$$

Let us make the calculations according to the relation

$$C_N(t', \beta) = C(t', \beta)\frac{\pi v}{K_0\omega_0}, \tag{11}$$

determining the modulus and independent variable.

Let us use the signal in the AMS in which attenuation is absent as the ideal signal.

Let us compare to the value of $C_{N\,id}(t', \beta)$ by using the metrics determined in (1). In this case let us fix moment of time $t_i > t_u$, where t_u is the length of the input electric signal (the moment of feeding the electric signal to the electroacoustic transducer of the modulator is taken as t = 0)

It is obvious that the distortions at the end of the aperture (at high values of t') are more significant. Consequently, being given the permissible value of the error and analyzing the possibility of using the AMS, one should fix those values of t_i' at which the signal will be close to the end of the AMS aperture.

Let us represent (1) in the following form for calculations:

$$\frac{\Delta_E(t_i')}{\Delta_{E\max}(t_i')} = \frac{\left\{\int_0^L [C_{N_{id}}(t_i'\beta) - C_N(t_i', \beta)]^2\, d\beta\right\}^{1/2}}{\left[\int_0^L C^2_{N_{id}}(t', \beta)\, d\beta\right]^{1/2} + \left[\int_0^L C^2_N(t_i', \beta)\, d\beta\right]^{1/2}}. \tag{12}$$

The results of calculating $C_N(t', \beta)$, $\phi(t', \beta)$ and $\Delta_E/\Delta_{E\max}$ are shown in Figures 2 and 3 at input electric signal

$$s(t) = \frac{\sin \Delta\omega_0 t}{\Delta\omega_0 t}\cos\omega_0 t.$$

Similar curves can be found at s (t) = δ(t). Thus, the given graphs correspond to the electroacoustic pulse reaction introduced in [4, 5]. The calculations were made for m = 100, a_0 = 0.3 and t_i' = 2/3.

It is obvious from Figure 2, b that the phase characteristic of a real complex envelope is distorted. However, the nature of these distortions is such that they can subsequently be disregarded.

Similar curves are presented in Figures 4 and 5 for an input radio pulse with square-wave envelope. Calculations were made for $t' = t_u/T = 1/3$, m = 100, a_0 = 0.3 and t_i' = 2/3. The graphs of the phase characteristic are not shown since $\phi(t', \beta) \approx 0$.

The given dependence of the normalized mean square error on α_0 permits one to select material for a light and sound conductor on the basis of the permissible distortions. Being given the permissible value of $\Delta_E/\Delta_{E\max}$ (for example, 10 percent), the maximum value of α_0 is determined at which the desired acoustooptical

interaction medium is found, varying by the values of f_0 and T. For example, α_0 = = 0.7 Np has a light and sound conductor 45 mm long (T ≈ 12.2 microns) on $PbMoO_4$ when a normal longitudinal elastic wave at f_0 = 300 MHz is excited in it. This attenuation will also have a light and sound conductor approximately 350 mm long (T ≈ 95 microns) manufactured from glass of mark STF-2 when a longitudinal elastic wave with f_0 = 10 MHz is excited in it.

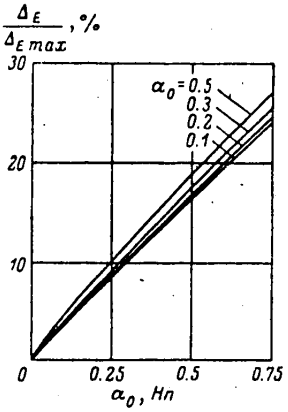

Figure 3. Dependence of Normalized Mean Square Error on $\alpha_0 f$ for s(t) = $= \frac{\sin \Delta\omega_0 t}{\Delta\omega_0 t} \cos \omega_0 t$.

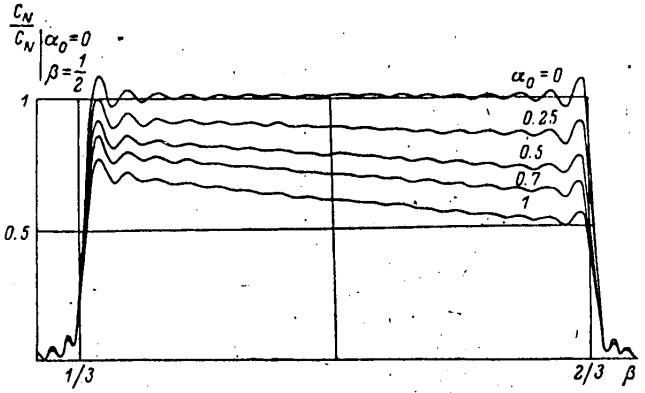

Figure 4. Modulus of Complex Signal Envelope at Aperture for s(t) = = cos ω at $0 \leq t \leq t_u$

Output Signal of the AOUKA

Theoretical investigations of the generalized block diagram of an ideal AOUKA (see Figure 6) were made in [4, 5]. It is shown that the current at the output of the photodetector (a photomultiplier with electric bandpass filter as load) placed at the point where the first-order diffraction maximum is formed, is determined by the relation

$$i(t)=\frac{2\pi B}{P}\int_{-\infty}^{+\infty} r\left[\frac{1}{Q}(v_1 t-y)\right] s_1\left[v_1\left(1-\frac{1}{PQ}\right)t+\frac{1}{PQ}y\right] s_2(y)\,dy, \tag{13}$$

where v_1 and v_2 are the velocities of elastic waves in AMS1 and AMS2, respectively, P is the ratio of the focal distance of optical stages (objectives) OK2 and OK1, $Q = \pm v_1/v_2$ (the sign of Q depends on the direction of elastic wave propagation in AMS2 [4, 5]), B is the dimensionless proportionality constant, r(y) is a weight function determined by the aperture of AMS1 and AMS2 and s_1 (t) and s_2 (t) are input signals. Subscripts 1 and 2 will subsequently show everywhere the affiliation of the parameter or value of s_1(t)--AMS1 and s_2 (t)--AMS 2.

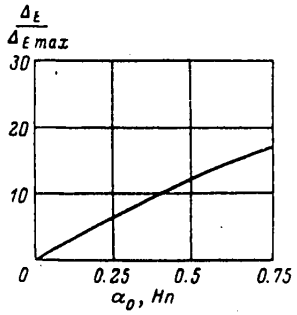

Figure 5. Dependence of Normalized Mean Square Error on α_0 for s(t) = = cos ω at $0 \leq t \leq t_u$

Making the substitution of variable $z_3 = \frac{1}{Q}(v_1 t - y_1)$ in (13), we find

$$i(t)=2\pi\frac{Q}{P}B\int_{-\infty}^{+\infty} r(z_3)\, s_1\left(v_1 t-\frac{z_3}{P}\right) s_2(v_1 t-Qz_3)\,dz_3. \tag{14}$$

Here z_3 has the meaning of space coordinate axis in the rear focal plane of stage OK2 (at the aperture of the AMS2). Since elastic wave attenuation occurs in real AMS, (14) should be written in more general form:

$$i(t)=B_1\int_{-\infty}^{+\infty} r(z_3)\, s_1\left(v_1 t,\ \frac{z_3}{P}\right) s_2(v_1 t,\ Qz_3)\,dz_3, \tag{15}$$

where $B_1=2\pi\frac{Q}{P}B.$

One is interested primarily in the output signal envelope when solving practical problems of correlation analysis. In our case it can be found from the relation

$$I(t)=\left|\int_{-8}^{+\infty} r(z_3)\,\dot{C}_1\left(v_1 t,\ \frac{z_3}{P}\right)\dot{C}_2(v_1 t,\ Qz_3)\,dz_3\right|, \tag{16}$$

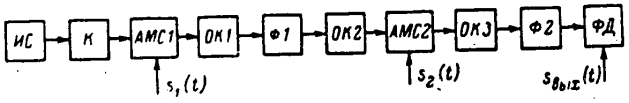

Figure 6. Generalized Block Diagram of Acoustooptical Device for Correlation Analysis of Signals: IS--light source; K--collimator; AMS1 and AMS2--acoustic light modulators; OK1, OK2 and OK3--optical stages that carry out Fourier transform; Φ1 and Φ2--bandpass filters of spatial frequencies; FD--photodetector

where $\dot{C}_1\left(v_1 t, \frac{z_3}{P}\right)$ and $\dot{C}_2(v_1 t, Qz_3)$. are complex signal envelopes of $s_1\left(v_1 t, \frac{z_3}{P}\right)$ and $s_2(v_1 t, Qz_3)$, respectively.

Let us omit the multiplier r (z_3) that determines the integration limits.

Let us write expression (16) using the parameters and relation (11) introduced earlier. Then

$$I(t') = \left| \int_{-\infty}^{+\infty} \dot{C}_{N_1}(t', \beta)\, \dot{C}^*_{N_2}(t', \beta)\, d\beta \right|, \tag{17}$$

where

$$\dot{C}_{N_1} = \int_{-a_0}^{+a_0} e^{-\alpha_{01}\beta(1-a_1)^2} \dot{S}_1(a_1)\, e^{j\frac{\pi m a_1}{a_0}[P|\theta|(t'-T_3'')-\beta]}\, da_1, \tag{18}$$

$$C_{N_2} = \int_{-a_0}^{+a_0} e^{-\alpha_{02}\beta(1-a_2)^2[\sigma(-Q)+\beta \operatorname{sign} Q]} \dot{S}_2(a_2)\, e^{-j\frac{\pi m a_2}{a_0}(t'-\beta \operatorname{sign} Q)}\, da_2. \tag{19}$$

It is assumed when deriving relations (18) and (19) that

$$a_0 = \frac{\Delta\omega_{01}}{\omega_{01}} = \frac{\Delta\omega_{02}}{\omega_{02}},\quad t' = \frac{t}{T_3},\quad \beta = \frac{z_3}{L_3} \quad \text{and} \quad m = 2\Delta f_{01} T_1 = 2\Delta f_{02} T_2.$$

Moreover, the following notations are used here:

$$\sigma(-Q) = \begin{cases} 1 & \text{at } Q < 0, \\ 0 & \text{at } Q > 0 \end{cases} \quad \text{and} \quad \operatorname{sign} Q = \begin{cases} +1 & \text{at } Q > 0, \\ -1 & \text{at } Q < 0. \end{cases}$$

The calculated output signal envelopes of a correlator in which P = 2 and Q = 1 for input pulses with envelope of form sin x/x and pulses with square-wave envelope are

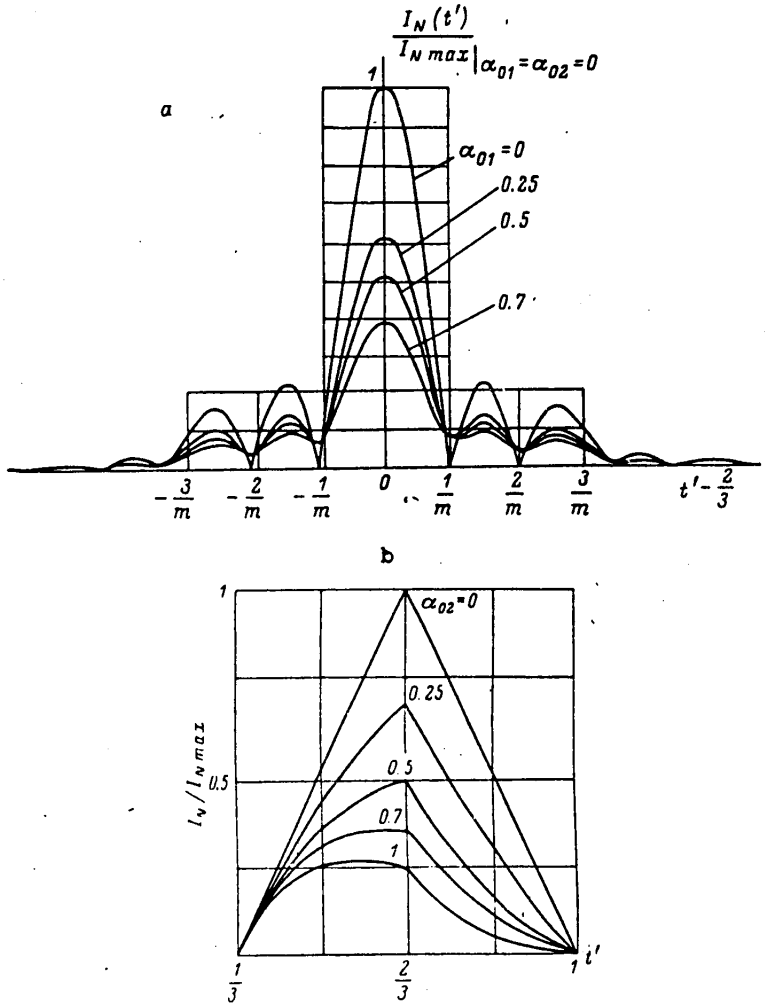

Figure 7. Output Signal Envelope of Acoustooptic Correlator with Input Pulses from Envelope of Type sin x/x (a) and with Square-Wave Envelopes (b): P = 2, Q = 1, $T_3' = T_3/T_2 = 1/3$, $\alpha_{01} = 2\alpha_{02}$; a--$a_0 = 0.3$; b--$t_{u2} = 2t_{u1}$

shown in Figure 7. P = 2 denotes that the signal in AMS1 is projected with twofold magnification onto AMS2; Q = 1 corresponds to the case when AMS1 and AMS2 are manufactured from the same material while the displacement of the signal image s_1 (t) and the signal in the AMS2 is accomplished in the same direction at velocities whose ratio is equal to 2 [4]. It was also taken into account in the calculations that $\omega_{01}/\omega_{02} = P|Q|$ (see [5] for a functional diagram of the device).

The corresponding dependence of the normalized mean square errors on α_{02} are presented in Figure 8.

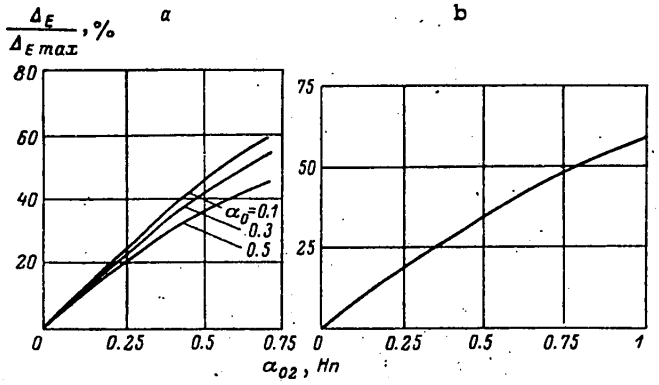

Figure 8. Normalized Mean Square Error for Output Signal of Correlator Corresponding to Figure 7, a (a) and 7, b (b)

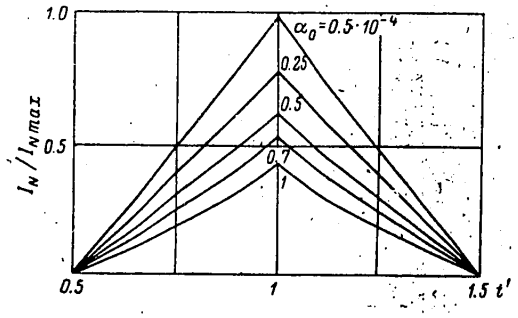

Figure 9. Output Signal Envelope of Acoustooptic Convolver at Input Pulses with Square-Wave Envelopes: P = 1, Q = -1, $t_{u1} = t_{u2}$ and $\alpha_{01} = \alpha_{02} = \alpha_0$

The results of similar calculations for the simplest convolver (P = 1, Q = -1) are shown in Figures 9 and 10. A schematic diagram of this device is presented in [5, 9].

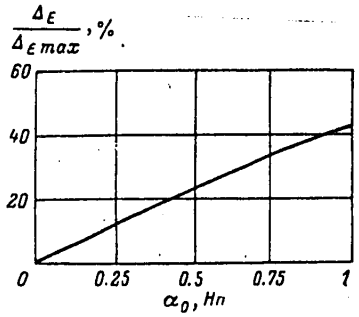

Figure 10. Normalized Mean Square Error for Output Signal of Acoustooptic Convolver Corresponding to Figure 9

Conclusions

Attenuation of elastic waves leads to distortions of the signal envelope in an AMS and distorts the shape of the output signal of the AOUKA. However, it hardly affects the phase characteristics of the comple signal envelope in the aperture. The distortions related to attenuation of elastic waves are linear and determine the instrument errors of the devices considered in the paper.

The given graphs link the normalized mean square error to the value of α_{02} (or α_{01}). They permit one to select an acoustooptic interaction medium (material of the light and sound conductor of the AMS) by the permissible value of this error. For example, if it is required that $\Delta_E/\Delta_{E\,max} < 10$ percent, then $\alpha_{02} < 0.2$. One can then select material in which $\alpha_{02} < 0.2$ under these conditions for given values of t_{u1} and t_{u2} (and consequently T_2 as well [5]).

The method of analyzing the distortions determined by elastic wave attenuation presented in this paper can also be used in analysis of other acoustooptic devices.

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6521
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EFFECT OF NONLINEARITY OF ACOUSTIC LIGHT MODULATORS ON CORRELATION PROCESSING OF NARROWBAND SIGNALS

Leningrad RADIOGOLOGRAFIYA I OPTICHESKAYA OBRABOTKA INFORMATSII V MIKROVOLNOVOY TEKHNIKE in Russian 1980 (signed to press 24 Oct 80) pp 174-178

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[Text] An acoustooptic correlation device (AOKU) in which a low level of input signals was suggested, was analyzed in [1, 2]. In this case acoustic light modulators (AMS) can be regarded as linear devices with respect to the input effects that carry out "linear" input of information to be processed in the optical system.

At high levels of input signals, the shape of the space-time signal in the sound conductor of an AMS remains unchanged (if the distorting effect of elastic wave attenuation is not taken into account). However, the modulating effect of this signal is such that would occur if there were a distorted signal in the AMS (a signal with nonlinear distortions). Thus, nonlinear input of information to be processed into the optical system occurs. It is obvious that the principle of superposition is not applicable here.

As is known, the nature of nonlinear distortions will be different with different input signals. The problem of analyzing these distortions is most simply solved for narrowband input signals.

Determined nonlinear vector models of an AOKU with narrowband input signals are found in this article.

It is shown in [1, 2] that a light wave with Raman-Nat diffraction after the second acoustic light modulator of an AOKU is determined by the relation

$$e_4'(t,\ z_3) = \frac{1}{p} E_0 \operatorname{rect}_2(z_3) \operatorname{rect}_1\left(\frac{z_3}{p}\right) e^{j\omega_{c3}t} e^{jA_1\varphi_1\left(\varphi_1 t - \frac{z_3}{p}\right)} e^{jA_2\varphi_2(\varphi_1 t - Qz_3)}, \quad (1)$$

where p is the ratio of focal distances of objectives that form the projection optical system, $Q = \pm v_1/v_2$, v_1 is the velocity of elastic waves in AMS1, v_2 is the velocity of elastic waves in AMS2 and $\text{rect}_1(z_3/p)$ and $\text{rect}_2(z_3)$ are aperture functions of AMS1 and AMS2.

Let the following narrowband pulse signals be fed to the inputs of this correlation device

$$s_1(t) = s_1(t)\cos[\omega_{01}t - \theta_1(t)], \quad t \in [0, t_{u_1}], \tag{2}$$

$$s_2(t) = s_2(t)\cos[\omega_{02}t - \theta_2(t)], \quad t \in [0, t_{u_2}], \tag{3}$$

where t_{u1} and t_{u2} are their lengths.

Signal (2) will create an elastic wave packet whose modulating function after reducing to the plane of AMS2 can be represented in the following form:

$$s_1(t, z_3) = A_1(t, z_3)\cos\left[\frac{\omega_{01}}{pv_1}(pv_1t - z_3) - \theta_1(t, z_3)\right], \quad t \in [0, t_{u_1}], \; z_3 \in [0, L_2]. \tag{4}$$

In similar fashion for signal (3) we have

$$s_2(t, z_3) = A_2(t, z_3)\cos\left[\frac{\omega_{02}Q}{v_1}\left(\frac{v_1t}{Q} - z_3\right) - \theta_2(t, z_3)\right], \quad t \in [0, t_{u_2}], \; z_3 \in [0, L_2]. \tag{5}$$

Substituting (4) and (5) into (1), we find for Raman-Nat diffraction

$$e_4'(t, z_3) = \frac{1}{p}E_0\,\text{rect}(z_3)\,e^{j\omega_{c3}t}e^{jA_1(t, z_3)\cos\left[\frac{\omega_{01}}{pv_1}(pv_1t - z_3) - \theta_1(t, z_3)\right]} \times e^{jA_2(t, z_3)\cos\left[\frac{\omega_{02}Q}{v_1}\left(\frac{v_1t}{Q} - z_3\right) - \theta_2(t, z_3)\right]}. \tag{6}$$

It is obvious that the range of representation (6) is determined by the range of representation (4) and (5).

Let us present relation (6) in the form of the product of two functional series with finite terms. Then

$$e_4(t, z_3) = -\frac{E_0}{p}\,\text{rect}(z_3)\,e^{j\omega_{c3}t}\sum_{n=-\infty}^{\infty} J_n(A_1)\,e^{jny_1}\sum_{m=-\infty}^{+\infty} J_m(A_2)\,e^{jmy_2\,\text{sign}\,Q}, \tag{7}$$

where $A_1 = A_1(t, z_3)$ and $A_2 = A_2(t, z_3)$ are the instantaneous modulation indices, $y_1 = \omega_{01}/pv_1(pv_1t - z_3) - \theta_1$, $y_2 = \omega_{02}|Q|/v_1[(v_1t/\theta) - z_3] - \theta_2\,\text{sign}\,Q$, $\theta_1 = \theta_1(t, z_3)$, $\theta_2 = \theta_2(t, z_3)$. The statement about the narrowband nature of $s_1(t)$ and $s_2(t)$ permits one to assume that the diffraction orders in the output plane of the optical system are non-overlapping. Consequently, one can isolate those terms from (7) which these orders form.

The product of the sums contained in (7) is written in the following form:

$$\sum_{n=-\infty}^{+\infty} J_n(A_1)\, e^{jny_1} \sum_{m=-\infty}^{+\infty} J_m(A_2)\, e^{jmy_2 \operatorname{sign} Q} = J_0(A_1)\, J_0(A_2) + \\ + \sum_{n=1}^{\infty} a_n \sum_{m \operatorname{sign} Q=0}^{\infty} b_m + \sum_{n=1}^{\infty} a_{-n} \sum_{m \operatorname{sign} Q=0}^{\infty} b_m + \sum_{n=0}^{\infty} a_n \sum_{m \operatorname{sign} Q=1}^{\infty} b_{-m} + \\ + \sum_{n=0}^{\infty} a_{-n} \sum_{m \operatorname{sign} Q=1}^{\infty} b_{-m}, \tag{8}$$

where

$$a_n = J_n(A_1)\, e^{jny_1}, \quad a_{-n} = (-1)^n J_n(A_1)\, e^{-jny_1}, \\ b_m = J_m(A_2)\, e^{jmy_2 \operatorname{sign} Q}, \quad b_{-m} = (-1)^m J_m(A_2)\, e^{-jmy_2 \operatorname{sign} Q}. \tag{9}$$

The terms of series (8) are represented in Cauchy form [3], i.e., in the form of infinite rectangular matrices whose elements are products of the terms of the series that form these partial sums. As an example let us present the matrix corresponding to $\sum_{n=1}^{\infty} a_{-n} \times \sum_{m \operatorname{sign} Q=0}^{\infty} b_m$ at $\theta > 0$:

$$\begin{bmatrix} a_{-1}b_0 & a_{-1}b_1 & a_{-1}b_2 & \dots & a_{-1}b_i \\ a_{-2}b_0 & a_{-2}b_1 & a_{-2}b_2 & \dots & a_{-2}b_i \\ a_{-3}b_0 & a_{-3}b_1 & a_3b_2 & \dots & a_{-3}b_i \\ \dots & \dots & \dots & \dots & \dots \\ a_{-j}b_0 & a_{-j}b_1 & a_{-j}b_2 & \dots & a_{-j}b_i \end{bmatrix}. \tag{10}$$

The convenience of this representation is that the sum of the subscripts for each element of the matrix is equal to the number of the diffraction exponent since it determines the numerical coefficient in front of z_3.

Thus, selecting the elements from the matrix of type (10) that form diagonals with sums of indices equal in absolute value and identical in sign, we find terms of series (7) that form the diffraction exponent of interest to us.

Thus, for example, at $Q > 0$, only $J_0(A_1)J_0(A_2)$ and those terms $\sum_{n=1}^{\infty} a_{-n} \sum_{m=0}^{\infty} b_m$ and $\sum_{n=0}^{\infty} a_n \sum_{m=1}^{\infty} b_{-m}$, at which n = m determine the zero order from (8).

Using this method, let us present a lightwave that forms the zero diffraction order (for positive and negative values of Q) in the form of a functional series

$$e'_{4,0}(t, z_3) = -\frac{E_0}{p} \operatorname{rect}(z_3)\, e^{j\omega_{03}t} \sum_{k=-\infty}^{+\infty} (-1)^k J_k(A_1) \times \\ \times J_k(A_2)\, e^{jk\omega_0 t\left(p - \frac{1}{Q}\right)} e^{-jk(\theta_1 - \theta_2 \operatorname{sign} Q)}. \tag{11}$$

The illumination corresponding to this light wave is:

$$\varepsilon_{4,0}(t,\ z_3)=$$
$$=\frac{1}{2}\left|\frac{E_0}{p}\operatorname{rect}(z_3)\sum_{k=-\infty}^{+\infty}(-1)^k J_k(A_1)J_k(A_1)\,e^{jk\omega_0 t\left(p-\frac{1}{Q}\right)_\Theta - jk(\theta_1-\theta_2\operatorname{sign}Q)}\right|^2. \tag{12}$$

The current at the photodetector output is proportional to the luminous flux, i.e., to the integral due to illumination of the aperture of AMS2. Thus,

$$i(t)=\frac{1}{2}B\int_{-\infty}^{+\infty}\operatorname{rect}(z_3)\left\{J_0(A_1)J_0(A_2)+\right. \tag{13}$$
$$\left.+2\sum_{k=1}^{\infty}(-1)^k J_k(A_1)J_k(A_2)\cos k\left[\omega_0 t\left(p-\frac{1}{Q}\right)-\theta_1+\theta_2\operatorname{sign}Q\right]\right\}^2 dz_3,$$

where B is the proportionality constant that also takes into account the photodetector sensitivity.

Since the photodetector (photomultiplier) has a bandpass filter tuned to median frequency $\omega_0(p - 1/Q)$ as a load, the corresponding terms should also be selected from (13).

Let us now limit the input signal levels so that the instantaneous modulation indices do not exceed values at which the diffraction maximums above third order would have to be taken into account. The useful component of current (13) can then be written in the following manner:

$$i_{0\sim}(t)=2B_2\int_{-\infty}^{+\infty}\operatorname{rect}(z_3)[J_0(A_1)J_0(A_2)J_1(A_1)J_1(A_2)+J_2(A_1)J_2(A_2)J_2(A_1)J_2(A)_2+ \tag{14}$$
$$+J_2(A_1)J_2(A_2)J_2(A_1)J_2(A_2)]\cos\left[\omega_0 t\left(p-\frac{1}{Q}\right)-\theta_1+\theta_2\operatorname{sign}Q\right]dz_3.$$

Carrying out similar analysis for the case when the photodetector is placed in one of the first diffraction orders, we find

$$i_{1\sim}(t)=2B_2\int_{-\infty}^{+\infty}\operatorname{rect}(z_3)[J_0(A_1)J_1(A_1)J_0(A_2)J_1(A_2)-J_0(A_1)J_1(A_1)J_1(A_2)J_2(A_2)- \tag{15}$$
$$-J_1(A_1)J_1(A_2)J_0(A_2)J_1(A_2)-J_1(A_1)J_2(A_1)J_2(A_2)J_2(A_2)-$$
$$-J_2(A_1)J_2(A_1)J_1(A_2)J_2(A_2)]\cos\left[\omega_0 t\left(p-\frac{1}{Q}\right)-\theta_1+\theta_2\operatorname{sign}Q\right]dz_3.$$

Thus, (14) and (15) are nonlinear determined models of an acoustooptic system that performs correlation processing of narrowband signals during Raman-Nat diffraction.

With Bragg diffraction (1) is written in the following form:

$$e_4'(t,\ z_3)=\frac{E_0}{p}\operatorname{rect}(z_3)\,e^{j\omega_{c3}t}\left[\cos 0.5A_1+\sin 0.5A_1 e^{j\left[\frac{\omega_{01}}{pv_1}(pv_1t-z_3)-\theta_1\right]}\right]\times \\ \times\left[\cos 0.5A_2+\sin 0.5A_2 e^{j\left[\frac{\omega_{02}Q}{v_1}\left(\frac{v_1t}{Q}-z_3\right)-\theta_2\right]}\right]. \tag{16}$$

Having performed simple transformations, we find

$$i_{1\sim}(t)=\frac{1}{2}B_2\int_{-\infty}^{+\infty}\operatorname{rect}(z_3)\sin A_1\sin A_2\cos\left[\omega_0 t\left(p-\frac{1}{Q}\right)-\theta_1+\theta_2\operatorname{sign}Q\right]dz_3. \tag{17}$$

Expression (17) is a nonlinear determined model of an acoustooptic system that carries out correlation processing of narrowband signals during Bragg diffraction.

Relations (15)-(17) take into account the nonlinearity of acoustic light modulators and permit one to make numerical calculations of the shapes of output signals of acoustooptic correlation devices and also the amplitude characteristics of parametric quadupoles based on them.

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APPLICATIONS

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AUTOMATION OF SETTLEMENTS WITH SUPPLIERS IN SUPPLIES AND SALES ORGANIZATIONS

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE, SERIYA 4: PRIMENENIYE MATEMATICHESKIKH METODOV, VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI V MATERIAL'NO-TEKHNICHESKOM SNABZHENII (NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK) in Russian No 3, Mar 80 pp 5-6

[Article by G. P. Bogdanova, senior engineer, computer center of the Volgo-Vyatskoye Main Territorial Administration, USSR Gossnab]

[Text] In the computer center of the Volgo-Vyatskoye Main Territorial Administration of the USSR Gossnab the problem "Settlements With Suppliers" has been worked out and introduced into the Association "Volgovyatmashelektrosnabsbyt."

The solution of the problem is based on information about the actually arriving goods, the bulk of which is created during recording of the movement of production and packing, and on information arriving from the bank about payments.

Invoices of suppliers which have arrived in the association accounting office through the bank or by mail are grouped according to the commodity divisions functioning in the association. Workers of the commodity divisions verify that the data of the supplier's documents match all the conditions of delivery, accept invoices of the supplier and write up arriving orders. In accordance with the data on the goods which have actually arrived, the incoming order is printed on "Zoyemtron-393" machines with perforator accessories in the electronic billing machine unit. The prepared punched tapes are transmitted daily for processing on a "Minsk-32" computer.

The accounting office transmits the verified and accepted invoices of suppliers to the computer center.

To make the settlements and print outgoing statements the daily mass of invoices monitored and formulated on magnetic tape is used, as are the daily mass of the arrival of goods by invoice items, the starting balances at the beginning of the month and the reference information "Characteristics of Supplier Enterprises."

The starting balance at the moment the task was introduced is entered from the 6-SN order register. The daily and monthly records of settlements with suppliers are made in a cross-section of each warehouse section and commodity division. The results of the settlements made with suppliers permit having data each day from

the beginning of the month in total against the starting balance of account 60 "Settlements With Suppliers and Contractors" (debit and credit); debit account 60 in accordance with the credit and credit account 60 in accordance with the debit of the accounts; credit the balance at the end of the month for account 60, credit for unbilled deliveries and debit for "goods in transit."

After the processing of data with a special complex of programs the information about the arrival of goods and invoices is grouped in output statements: the invoice register, the statement of the arrival of goods, the statement of settlements with suppliers for warehouse deliveries, the statement of "goods in transit" and unbilled deliveries.

Computer solution of the problem contributed to increase of the effectiveness of monitoring settlements with suppliers for each invoice, the adoption of effective measures for the timely arrival of "goods in transit" and "unbilled deliveries" and the timely and reliable obtaining of accounting data assuring the synthetic and analytical recording of settlements with suppliers both for the association as a whole and for subdivisions.

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PRINCIPLES OF SOFTWARE OF 'NEFTEPRODUKT'

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE, SERIYA 4: PRIMENENIYE MATEMATICHESKIKH METODOV, VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI V MATERIAL'NO-TEKHNICHESKOM SNABZHENII (NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK) in Russian No 3, Mar 80 pp 12-13

[Article by A. D. Fishel', section chief of "Nefteprodukt" Central ASU Design Bureau]

[Text] To solve problems based on the YeS-1033 computer, in the Central ASU Design Bureau of "Nefteprodukt" a second line of a package of applied programs has been created, one assuring the processing of sets of data on direct-access equipment (PPP "RIP-2-15C") under the control of a YeS operating system.

The RIP is characterized by a traditional approach to data processing. An advantage of the method of discrete sets consists in more rapid results than with an integrated approach (data banks), and a shortcoming is the fact that the creation of different sets which include different information on the same objects and make use of information from different sources can lead to incompatibility and mutual non-equivalence of the data.

The RIP uses a magnetic disk store for basic storage and data processing and magnetic tapes for long-term storage.

The methods of processing sets assure rapidity, precision and completeness of data retrieval, reliability, simplicity and convenience of operation and the ordering of information in the absence of careful external sortings.

The RIP represents a complex of programs, a language of user-RIP interaction and RIP data sets.

The programs permit formulating, correcting and opening up consecutive-index sets, looking up and reading RIP information, etc. They use the entire RIP and OS arsenal for optimum performance of input-output operations and the discovery, analysis and location of possible errors.

The language of user-RIP interaction is a set of concepts, agreements and rules which permit receiving and renewing information of data sets, looking up and issuing the necessary information and analyzing the arising situations.

All the RIP sets are of the consecutive-index type with blocked recordings of taken-down data. The basic principle of the logical organization of recordings is the field structure of the recording, in which the recording consists of fields singled out by the user for storage of data of a specific type. The speed of retrieval and reading of data is achieved because of the absence of regions of redundancy in the set storages, the presence of information in which greatly slows down the reading. Information is corrected, not in the data set storages, but in the RIP set corrector, which permits realizing invariability and independence of the organization of sets from the correction methods. The RIP set catalog contains certain information about the disposition of sets, the results of successive correction, etc.

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IDENTIFICATION OF PROGRAMS AND DATA FILES IN USSR GOSSNAB INFORMATION SYSTEM

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE, SERIYA 4: PRIMENENIYE MATEMATICHESKIKH METODOV, VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI V MATERIAL'NO-TEKHNICHESKOM SNABZHENII (NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK) in Russian No 6, Jun 80 pp 1-2

[Article by A. I. Pronchenkov, deputy section chief, Main Computer Center, USSR Gossnab]

[Text] The USSR Gossnab Information System (first line) has been developed and introduced in the USSR Gossnab Main Computer Center.

In working out the information system, internal standards were introduced into a minicomputer for the identification of software, data files and the standard-reference complex, and also some special standards connected with distinctive features of the technical base of the information system.

The programs and data files are identified by serial number. The identifier has a length of 8 bytes and determines:

1. That the set belongs to the class of programs or ddat files, and also that it belongs to the information system.

1.1. For programs relating to the information system, the first four symbols must be "ISOR." For programs not relating to the information system the identifier is established specially in each specific case and is entered in the system as permitted.

1.2. For data files relating to the information system, the first four symbols must be "ISOR." For data files not relating to the information system, the identifier is established specially in each specific case and is entered in the system as permitted.

2. That the set belongs to some specific task.

2.1. Symbols 5 and 6 in the identifiers of programs and data files indicate that they belong to a certain task in the information system and can vary in the range of 00-99.

3. The specific number of the data file or program.

3.1. Symbols 7 and 8 of the identifier determine the number of the program or data file within a specific task. The identifier of dictionaries also contains 8 symbols and has the following form: SLOV No, where No is the number of the dictionary, which varies in the range of 00-99. There also is a service file of the normative-reference complex, which is called "GLOSSARY" and contains information about all the dictionaries activated in the system.

There also is a number of standards introduced due to structural features of the minicomputers and the absence of an operating system in them. Thus, on a disk a place is allotted for storage of the data and ordinal number of the current day in the year (the date is entered each time the system is loaded), for storage of the disk number and the date of the last reorganization of data on it, and for storage of the number of the minicomputer complex.

The introduction of a single identification in the information system permits putting in order the arrangement of the data files and programs on disks of information complexes, writing a number of programs which simplify data file maintenance and facilitates the writing of applied programs.

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SANCTIONED ACCESS TO DATA IN USSR GOSSNAB INFORMATION SYSTEM

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE, SERIYA 4: PRIMENENIYE MATEMATICHESKIKH METODOV, VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI V MATERIAL'NO-TEKHNICHESKOM SNABZHENII (NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK) in Russian No 6, Jun 80 pp 4-5

[Article by A. I. Pronchenkov, deputy section chief, Main Computer Center, USSR Gossnab]

[Text] The introduction of sanctioned access to data in the USSR Gossnab Information System was stipulated by the need to limit the circle of users of the system.

Sanctioned access permits putting in order the obtaining of inquiries on various problems and protecting information stored in the system.

On the system level, access to data is protected by the use of user identifiers and passwords. For each user of the system an especially selected responsible person establishes a personal identifier and an original password. During each reference to the system the user must present himself with his identifier and password, which are then verified in the list of system users and, if they are not present there or do not correspond with one another, the attempt to enter the system is denied.

Each user is given the right to change his password as desired at any time. The identifier is changed only by the especially selected person.

On the data level, protection is accomplished in the following manner. The management establishes a list of problems accessible to each user, and within each task the degree of competence of the user is determined, that is, the working conditions of the user for the given task (data reading, data renewal, change of programs for the task, etc). The system gives the user the possibility of access only to tasks determined to be permitted for him and of working on a selected task only under the conditions permitted him for that task. The system is entered from a terminal in an interactive mode.

Sanctioned access assures three levels of access to data and programs of the information system: the chief dispatcher level, the level of the central apparatus user and the special level.

The chief dispatcher level permits having access to all information in the system only in the data reading mode, except information of the special level. The level

of the central apparatus user permits having access to reading and recording of information on tasks permitted to each specific user. The special level permits having access to individual information only to the user himself with additional passwords for a specific task.

The introduction of sanctioned access will permit excluding unqualified access to the system, putting information renewal in order and limiting the circle of users for each specific task, which is necessary in collective-use systems.

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FORMING AND ISSUANCE OF CERTIFICATES OF MOST IMPORTANT LINES

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE, SERIYA 4: PRIMENENIYE MATEMATICHESKIKH METODOV, VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI V MATERIAL'NO-TEKHNICHESKOM SNABZHENII (NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK) in Russian No 6, Jun 80 pp 6-7

[Article by I. B. Ayngorn, deputy section chief, and senior engineer Yu. N. Anurov, Main Computer Center, USSR Gossnab]

[Text] The task "Forming and issuance of certificates of the most important lines" has been developed and introduced into industrial operation within the framework of the first line of the USSR Gossnab Information System. The task was accomplished on a minicomputer and is intended to implement monitoring during the introduction of capacities into operation during the course of construction and equipping of the most important lines of enterprises for mineral fertilizer production. The task is solved monthly.

The complex of minicomputer programs permits monitoring up to 500 lines for 30 indicators. The indicators include the introduced capacities for each line, the volumes of capital investments and construction and installation work, the numbers of workers, the delivery of raw materials and supplies, the delivery and installation of equipment and reinforced-concrete and metallic structures.

The volume indicator, deadline for putting in operation and the actually introduced volume are kept track of for each capacity. An annual plan, a plan for the report period and fulfilment of the plan from the beginning of the year in an increasing total are prepared for the remaining indicators.

Provision has been made for two kinds of data input: automatic, from magnetic tape obtained as a result of solution of the problem of deliveries of metalwork on the YeS computer, and manual, from documents and displays on video terminals. The complex permits issuing documents in the form of reports from a video terminal on a screen or printer.

There is the possibility of obtaining the certificate of a specific line on all the mineral fertilizer lines in succession, starting from any one of them, and also summary data in a cross-section of contractor, customer, territorial organ or for all mineral fertilizer lines. Two days were required for that work when it was done manually, and after automation of the issuance of certificates not more than

1 minute was required. This made it possible to issue certificates on mineral fertilizer lines monthly, whereas when it was done manually they were issued quarterly.

Address for inquiries: Moscow, Orankov per 5, Main Computer Center, USSR Gossnab.

2174
CSO: 1863/264

UDC 681.32.06:[658.711.2+339.6](474.5)

COMPLEX OF TASKS IN DETERMINING MINERAL RESOURCES REQUIREMENTS OF LITHUANIAN SSR NATIONAL ECONOMY

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE, SERIYA 4: PRIMENENIYE MATEMATICHESKIKH METODOV, VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI V MATERIAL'NO-TEKHNICHESKOM SNABZHENII (NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK) in Russian No 6, Jun 80 pp 14-15

[Article by K. A. Lyaugminas, deputy chief, Republic Computer Center, and V. V. Stoshkus, section chief, Republic Computer Center]

[Text] The Republic Computer Center of the Lithuanian SSR Gossnab has developed and introduced a complex of tasks in determining the requirements of the national economy of the republic for material resources on a group and specified products list. The group products list includes the production, the balances and plans for the distribution of which are prepared by the USSR Gossnab. The complex of tasks is oriented toward the existing organizational structure of the Lithuanian SSR Gossnab with consideration of interaction with the second level of the Lithuanian SSR Gossnab ASU (soyuzglavsnabsbyts and soyuzglavkomplekts) and with related systems of the republic. The informational interactions of those systems are accomplished on the basis of a standardized system of documentation of material and technical supply with use of the production coding system adopted in the soyuzglavsnabsbyts and soyuzglavkomplekts.

The reliability of formation of input documents is monitored in two stages: when the documents are transferred to the users and when the data are processed on the computer. In the first stage the specialized administrations before order assignment inform the users about the assignment order, and in that case special attention is given to the reliability of the codes. Applications from users are received by special delivery after careful checking of the filling of all codes by them.

In the second stage counting and logical monitoring of the data are accomplished by a programmed method in the Republic Computer Center.

In the process of solving the complex of tasks five types of machine reports are formed: "Summary executive balance" (M1) with a summing up of the results for the fund holder and group of production, "Record of production requirements" (M2) with a summing up of the results for the fund holder and group of production, "Summary report of production requirements" (M3), "Report of orders for delivery of specified production (in a cross-section of the bases" (M4), with a summing up of the

results on type, variety, brand and size and group of production, and "Summary report of orders for delivery of specified production" (M5), with summing up of the results on type, variety, brand and size and group of production

Machine reports are used by workers of specialized administrations for work with users and substantiation of the needs of the republic for material resources.

The software was created on the basis of a package of applied programs prepared in "Ukrglavsnabsistema" Production-Technical Association for the "Minsk-32" computer.

Introduction of the complex of tasks permitted considerably improving the quality and reliability of order assignment. The actual saving from introduction of the task amounted to 162,400 rubles per year.

Address for inquiries: 232006, Vilnius, ul Partizanu, 57, Republic Computer Center Lithuanian SSR Gossnab.

2174
CSO: 1863/264

UDC 025.43.06:[681.3.06:519.682]

TECHNOLOGICAL PROCESS OF DEVELOPING VOCABULARY FOR YES COMPUTER

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE, SERIYA 4: PRIMENENIYE MATEMATICHESKIKH METODOV, VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI V MATERIAL'NO-TEKHNICHESKOM SNABZHENII (NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK) in Russian No 12, Dec 80 pp 11-13

[Article by V. S. Birger, group leader, "Les" ASU section, M. V. Shestyakov, computer center deputy chief, and V. Ya. Shmidtman, head, NSI (not further identified) section head]

[Text] In the computer center of the Krasnoyarsk Main Territorial Administration of the USSR Gossnab, in work on the creation of a vocabulary for the YeS computer common to the entire system, a variant of text curtailment and punching during data input into the computer was proposed. Processing languages written in the PL/1 language have been prepared for implementation of the proposed method.

The newly developed technological process has the following appearance:

1. During punching of the production vocabulary in abbreviated form the punched data include the items and GOST's, the initial codes of the standard size groups and the increase of codes, and within the groups, a list of standard sizes. In addition, the ordinal numbers of the cards in the pack are punched, starting with ity.

2. Each pack is processed in the input flow of programmed input, which generates lines of the vocabulary, computing successively the production codes by means of the given increase and forming complete texts from the recurrent part and standard sizes.

The formed recordings are brought out into the next set in the volume of external memory and printed out with decimal numbers which are read off from the start of the set.

Changes can be introduced in the set in the volume of external memory by means of a vocabulary editing program. The program CLSFRDP realizes such functions as removal of recordings according to their decimal numbers, insertion or removal of discrete symbols of the textual part, replacement of some symbols by others, correction of production codes and also the printing out of recordings with their ordinal numbers.

3. The adjusted and corrected vocabulary is put in order in accordance with the growth of the production codes by means of a programmed system.

4. The program CLSFRPC for monitoring and printing out codes permits printing out completely or partially the vocabulary, organized as a successive set in complete form or shortened (only the production code).

5. The IEGISAM system program transfers the finished vocabulary into a volume of direct access, equipping it with successive index organization.

6. The vocabular correction program in a volume of direct access CLSFRDP permits the removal, replacement or addition of recordings to the vocabular, organized as a successive-index set. In that case all the correction is brought out to the printer.

7. The printing of the vocabulary out in the form of a classifier with addition of a vocabulary of group names of products is done according to the program CLSFRPR. The printing-out intervals are given by an order in the input flow.

The application of an improved technological process to create large vocabularies will permit reducing the labor-intensiveness of work on the preparation of texts of the vocabulary and punching by three fourths and facilitate the selection of optimal conditions for the correction and management of vocabularies.

Address for inquiries: 660025, Krasnoyarsk, pr Krasnoyarskiy rabochiy, 144, Computer Center, Krasnoyarsk Main Territorial Administration, USSR Gossnab.

2174
CSO: 1863/264

UDC 681.3.06:[657.432.5:658.7/.8.000.06]

STATE OF DEBTOR INDEBTEDNESS OF REPUBLIC CONSUMERS TO ORGANIZATIONS OF AZERBAIJAN SSR GOSSNAB

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE, SERIYA 4: PRIMENENIYE MATEMATICHESKIKH METODOV, VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI V MATERIAL'NO-TEKHNICHESKOM SNABZHENII (NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK) in Russian No 1, Jan 81 pp 2-3

[Article by F. A. Gasanov, section head, Republic Computer Center, Azerbaijan SSR Gossnab, and A. M. Guseynov, senior engineer]

[Text] The task "Recording of debtor indebtedness of enterprises of the republic to organizations of Azerbaijan SSR Gossnab" is being solved on a "Minsk-32" computer in the Republic Computer Center of the Azerbaijan SSR Gossnab. In the machine report received twice a month data are presented on the debtor indebtedness of enterprises of the republic as a whole to Gossnab, including to organizations subordinate to it.

To effectively provide the management of Gossnab of the republic with brief information about the debtor indebtedness of ministries (departments) in 1980 the Republic Computer Center of the Azerbaijan SSR Gossnab developed and introduced a draft of the task "Formulation of effective reference information on the state of debtor indebtedness of consumers of the republic to organizations of the Azerbaijan SSR Gossnab" with the use of minicomputers.

The input information of the task is the machine report "Report on the recording of debtor indebtedness," obtained on a "Minsk-32" computer. In addition, the directory of the ministries (departments) is used as normative-reference information in solving the task.

The output information is "Inquiry about the state of debtor indebtedness of consumers of the republic to organizations of the Azerbaijan SSR Gossnab." The inquiry is printed on an alphanumeric printer and the conclusion of the inquirer on a display screen.

The task is solved by means of a program working in five modes: data input, print out of the inquiry on an alphanumeric printer, print out of the inquirer of ministries on an alphanumeric printer and readout of the inquirer on a display screen.

Data are entered in the memory of a minicomputer from the display keyboard, and in that case programmed monitoring of the entered data is accomplished (arithmetic correlation between data of a line is used for monitoring).

Data on the final line are entered last. Then the minicomputers vertically monitor all the introduced lines. In case of error the data are entered repeatedly. When each line is entered the correctness of the code set of the ministry is verified.

The introduction of the task provides the management of Gossnab of the republic with aggregated information on the state of debtor indebtedness on the whole to Gossnab, including to organizations subordinate to it, and provides the possibility of adopting effective measures for its regulation.

2174
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UDC 658.3.012:681.3.06

AUTOMATION OF PROCESS OF PERSONNEL ADMINISTRATION

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE, SERIYA 4: PRIMENENIYE MATEMATICHESKIKH METODOV, VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI V MATERIAL'NO-TEKHNICHESKOM SNABZHENII (NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK) in Russian No 1, Jan 81 pp 4-5

[Article by I. A. Yashayev, group head, and D. S. Petrosyan, senior mathematician, Republic Computer Center, Azerbaijan SSR Gossnab]

[Text] In the Republic Computer Center of the Azerbaijan SSR Gossnab a complex of tasks "Automated record-keeping and selection of personnel in the Gossnab of the republic (the main territorial administration)" has been developed.

The complex of tasks is being planned on the basis of the YeS-1022 computer with the use of the algorithmic languages PL/1 and COBOL.

The complex of tasks is intended for the centralized collection of information about workers of the territorial organ at the computer center, the formation and issuance upon request of inquiries on positions and workers satisfying definite requirements; the conducting of an analysis of the organization and position structure of the administration and the conducting of an analysis of the composition and movement of personnel.

The analysis is made on the basis of features determined in a survey.

The analysis of tasks is planned with consideration of the following requirements: standardization of the report documents on personnel; the creation of a personnel information retrieval system; the application of union-wide classifiers in the formation of a vocabulary fund; standardization of machine reports formed as a result of solution of the task.

To solve the complex of task report machine-oriented documents are introduced: "Worker's report card," "Form for making changes in worker's reported characteristics" and "Form for change in workers' positions," as the available report documents are not adapted to computer processing. In the development of the information retrieval system provision has been made for the possibility of adjusting to the varying structure of the machine-oriented started documents.

To realize the algorithm for obtaining the output machine reports, provision has been made for the grouping of all the starting information into three data bases:

the basic, including the organization and position structure of the administration and information about individual workers on the official list; the "Archive," containing the necessary information about workers excluded from the official list (in that case the "Archive" is subdivided into short-term and long-term) and inquiries necessary to obtain the output machine reports (continuous and one-time inquiries).

The content of specific output machine reports is determined by the content of the corresponding inquiries. The output machine reports are used by personnel subdivisions for the compilation of statistical reports and inquiries about personnel, and also the analysis and adopting of administrative decisions on personnel questions. The principles laid down in the planning of the complex of tasks permits using it also in other territorial organs of the USSR Gossnab.

2174
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ANALYSIS OF STATE STANDARDIZED WORKING CAPITAL AND CURRENT ASSETS

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE, SERIYA 4: PRIMENENIYE MATEMATICHESKIKH METODOV, VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI V MATERIAL'NO-TEKHNICHESKOM SNABZHENII (NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK) in Russian No 1, Jan 81 pp 16-17

[Article by V. I. Smelyanskiy, senior engineer, Main Computer Center, USSR Gossnab]

[Text] The task of analysis of standardized working capital and standardized current assets has been developed and introduced into the Main Computer Center of the USSR Gossnab. The task consists in the composition of a complex for analysis of the indicators of financial activity of the subsystem of planning and financial activity of the USSR Gossnab ASU. Data are processed and the output documents are issued on a YeS-1040 computer.

The main software of the task is a data base which assures the input, storage, renewal, checking and correction of dictionaries and files.

Tasks of analysis are solved on the basis of accounting records, which are entered quarterly in the data base of the subsystem of planning and financial activity of the USSR Gossnab ASU.

The main indicators according to which the standardized working capital is analyzed are: equipment (Soviet and imported), materials structures and low-valued objects, accounts receivable, uncredited assets and above-quota uncredited assets.

A questionnaire is prepared with consideration of deviations of the actual balances from the established standard of self-owned assets.

The result of solution of the problem is formulated in a summary report on USSR Gossnab organizations in a cross-section of the main territorial administrations, the soyuzglavsnabsbyts and soyuzglavkomplekts, the gossnabs of union republics and other organizations. The report is prepared from the results for a quarter, a half-year, 9 months and a year.

Introduction of the task permitted providing workers of the planning and financial administration with reliable and timely information about the financial situation of the branch and made it possible to free workers from uncreative manual data processing operations and use the freed time for more profound analysis of processes of material and technical supply.

Address for inquiries: Moscow, Promyshlennyy proyezd, d 3, Main Computer Center, USSR Gossnab.

2174
CSO: 1863/264

UDC 681.518:[658.7/.8.012:662.6]

DEVELOPMENT AND INTRODUCTION OF COMPLETELY AUTOMATED SYSTEM FOR COLLECTING AND PROCESSING DATA ON NATIONAL ECONOMY'S FUEL SUPPLY

Moscow MATERIAL'NO-TEKHNICHESKOYE SNABZHENIYE, SERIYA 4: PRIMENENIYE MATEMATICHESKIKH METODOV, VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI V MATERIAL'NO-TEKHNICHESKOM SNABZHENII (NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK) in Russian No 4, Apr 81 pp 5-6

[Article by I. N. Kryuchkov, group head, Main Computer Center, USSR Gossnab]

[Text] Work is being done in the USSR Gossnab on the creation of a single statewide automated information system for fuel supply. In 1979 the first line of the system was turned over to industrial operation by the Main Computer Center of the USSR Gossnab. The "Fuel" Information System ("Toplivo" IS) is oriented toward the accomplishment of functions of operative monitoring and analysis of the state of fuel deliveries to the national economy and effective tracking of fuel stocks in industry. In it provision has been made for automated processing of input and output data, the preparation of controlling documents for decision-making and an interactive mode of man-computer communication.

In the structure of the "Fuel" Information System the leading place has been allotted to a distributed data base which performs functions of data accumulation, storage, renewal and retrieval necessary for the solution of tasks in directory servicing of the administrative apparatus, prediction of fuel supply processes for many days, operative analysis and regulation of the functions of suppliers in assuring the fulfilment of fuel delivery plans. Realization of conceptions of the data bank under the conditions of a system for control of the fuel supply of the national economy proved possible only in conditions of the distribution of both the information itself and of its processing on hierarchic levels of administration.

In the "Fuel" Information System practical verification of the principle of distributed data processing has proceeded on the level of the control apparatus of the USSR Gossnab. At the Central Information Point of the USSR Gossnab Main Computer Center, on the basis of minicomputers a computer group has been formed which is intended for performance of operations of collection of primary information in the system. Questionnaires are issued to the administrative apparatus by the computer group located in the section for monitoring fuel deliveries to the national economy. The interconnected work of those groups assured the development and introduction of 13 tasks of the first line of the "Fuel" Information System. The computer group network already embraces Soyuzglavugol', Soyuzglavneft' and RSFSR

Goskomnefteprodukt. Also planned is the organization of automated collection of operative data over communication channels from oil supplier organizations of the union republics and uglesbyts, and exchange of information between machines with the fuel and energy administrations. Introduction of the second line of the "Fuel" Information System is to be accomplished in 1980-1983 with an annual saving of at least 100,000 rubles.

Address for inquiries: Moscow, Orlikov per. 5, Main Computer Center, USSR Gossnab.

2174
CSO: 1863/264

UDC 681.32.06:[658.155.012.7:658.7/.8]

ANALYSIS OF TRADE TURNOVER, INCOMES, DISTRIBUTION COSTS AND PROFITS OF USSR GOSSNAB ORGANIZATIONS

Moscow MATERIAL'NO-TECHNICHESKOYE SNABZHENIYE, SERIYA 4: PRIMENENIYE MATEMATICHESKIKH METODOV, VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI V MATERIAL'NO-TEKHNICHESKOM SNABZHENII (NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK) in Russian No 4, Apr 81 pp 13-14

[Article by V. I. Smelyanskiy, group head, Main Computer Center, USSR Gossnab]

[Text] A task of analysis of trade turnover, incomes, distribution costs and profits of USSR Gossnab organizations has been developed and introduced in the Main Computer Center of the USSR Gossnab within the framework of the subsystem of planning and financial activity of the USSR Gossnab ASU. The task is included in the complex of tasks in analyzing indicators of financial activity. The computations are made on a YeS-1040 computer.

The starting information for solving analytical tasks is taken from the data base of the subsystem of planning and financial activity of the USSR Gossnab. The data base, in turn, is formed from quarterly accounting reports.

The main indicators of trade turnover in the system of computer calculations are: wholesale sales (total); sales of goods ex warehouse; sales of goods through stores; sales of goods directly from producer to consumer with and without participation in the computations; release of goods within the system ex warehouse and direct from producer to consumer with participation in the computations; sales and release of materials, work and services.

The analysis is made on the basis of the following income indicators: from sales of goods ex warehouse, through stores, directly from producer to consumer with and without participation in calculations; incomes from release of goods through the system; incomes from other sales; total income.

The data of tasks of analysis of trade turnover and incomes of USSR Gossnab organizations are used in solving the task of analyzing costs and profit.

The main indicators of costs and profit are: expenses of warehouses, bases and stores; transportation expenses; expenditures on delivery and shipment of goods; warehouse expenses, non-productive expenses; expenditures of organizations subordinate to the USSR Gossnab; profit from sales.

The result of solving the task is formulated in a summary report on costs and profit for organizations of the USSR Gossnab in a cross-section of the main territorial administrations, soyuzglavsnabsbyts, soyuzglavkomplekts and gossnabs of the union republics and other organizations. The report is issued 4 times a year on the results for a quarter, a half-year, 9 months and a year.

Introduction of the task under consideration has permitted greatly reducing labor expenses and improving the quality of analysis of indicators of trade turnovers, distribution costs, incomes and profit.

Address for inquiries: Moscow, Promyshlennyy proyezd 3, Main Computer Center, USSR Gossnab.

2174
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UDC: 658.012.011.56:656.2

AUTOMATED SYSTEM FOR OPERATIVE CONTROL OF OPERATIONAL WORK OF A RAILROAD (ASUDO-D)

Moscow ZHELEZNODOROZHNYY TRANSPORT, SERIYA VYCHISLITEL'NAYA TEKHNIKA: NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK in Russian No 2, Jul-Dec 80 (signed to press 10 Sep 80) pp 1-32

[Booklet entitled "Avtomatizirovannaya sistema operativnogo upravleniya ekspluatatsionnoy rabotoy dorogi (ASUDO-D)" (Automated System for Operative Control of Operational Work of a Railroad [ASUDO-D])] by A. L. Pisarev, chief of the PKTB ASUZhT; Candidate of Technical Sciences R. A. Sakov, division head; G. L. Shelenyakov, division head; D. A. Sosnov, A. F. Feoktistov, A. S. Kuz'min, and Ye. I. Skladchikov, chief project engineers]

[Excerpts] Edict of the Ministry of Railroads No 30Ts dated 10 May 1978, entitled "On improvement of the technology of the transportation process and increase of the efficiency and quality of work of the railroads" and "Complex program for the development and increase of the efficiency of automated control systems in railroad transportation"; provision is made for the creation in 1980-1982 in the main directions (west-east, above all) of automated systems for operative control of the operational work of railroads--systems new in principle, based on information arriving from primary sources, which permit realizing not only a referral mode but also the solution of problems in planning and predicting work indicators, the optimization of various processes and interconnection with the ASU of line enterprises and the Ministry of Railroads. As a result of pre-planning developments by the Planning, Design and Technological Bureau (PKTB) of ASUZht, the VNIIZht (All-Union Red Banner of Labor Scientific Research Institute of Railroad Transport), the computer centers of the Belorusskaya, Oktyabr'skaya, Yugo-Zapadnaya, Yuzhno-Ural'skaya, Sverdlovskaya, Gor'kovskaya and Vostochno-Sibirskaya railroads, the technical task for such an ASUDO-D system has been developed and approved by the Ministry of Railroads (No a-2657, dated 23 January 1979).

In the process of pre-planning investigation a basic list of functional problems to be solved was determined, and also a list of the starting data for their realization, the information was systematized and informational messages were made up assure the solution of 90 percent of all the tasks of the system; missing information is entered by means of special messages. The main distinctive feature of all the messages is that they were developed on the basis of unified requirements for their structure in order to assure generality of the technology of work with them on all levels and processing in computer centers by means of unified standard programs. In the creation of the system the requirement of a single input of information was observed.

The system being developed consists of two parts. The general system part of ASUDO-D envisages the collection of necessary information, its input into the computer, monitoring and correction, the formation of general and specialized data bank files, and the formation and issuance of results to users by standard means. The practical part of the system implements procedures for the solution of functional problems; in that case it is assumed that all the information (both variable and normative-reference) is present in the computer in a form prepared for the given problem.

Division of the system into the general system and practical parts permits greatly reducing labor expenditures on program development, as input-output procedures are worked up once (analysis shows that the working up of those procedures for an individual problem occupies 40-45 percent of the total labor expenditures) and makes possible parallel elaboration of both parts, which leads to a curtailment of the total times required for creation of the system.

The actual system for control of the operational work on the railroad level is limited in its possibilities by facilities for the manual collection and processing of primary information, which do not provide the urgency, reliability and completeness of data on the entire variety of operational events on the monitored sections of railroads which are necessary for the development of both parts.

The limitations are reduced basically to the following:

--the periodicity of the obtaining of basic data for control of the transport process (freight car pools, rolling stock transmission over link-up points, loading, unloading, train position) is limited in operational reporting to days and in dispatcher reports and summaries to half-days;

--forecasting of future work and possible difficulties, especially for 2-3 or more days, in the manual variant is practically impossible due to complexity in the collection of the information needed for that and the need to use as a basis in calculations a large number of mutually influencing factors in short periods;

--the impossibility of accomplishing in the existing control system effective monitoring of the state and dislocations of individual units of the rolling stock (refrigerator units, self-contained refrigerator cars, transporters, etc);

--the presence, during the monitoring of observance of the established technology and standards of operational work, of labor-intensive work with manual selection of individual data, which on the whole does not give a complete characterization of the situation. This applies, for example, to monitoring violations of the plan for formation and shipping by directions, the provision of shunting yards with complete lists by telegram of all trains arriving for break-up, to monitoring of their quality, etc.

The main purpose of the development and introduction of the ASUDO-D is the elimination of those limitations; the assurance on that basis of the necessary effectiveness and completeness of data characterizing the operational situation on the railroad; reduction of the time required for estimating the production situations by operations workers and help in decision making by them; reduction fo the time for bringing the results of a decision to executives; efficient and operative monitoring of execution.

With consideration of distinctive features of the transportation process the ASUDO-D must:

--process and present to managers of various ranks a large quantity of accounting and report data as compared with the standard and planned tasks;

--organize data characterizing the general operating situation on large sections with consideration of the interconnection and dynamic interaction of controlled and monitored objects;

--assure the necessary effectiveness and depth of primary information, the forecasting of expected results of work for the purpose of timely prediction of possible failures and tracking dislocations of separate categories of trains and types of rolling stock.

To bring the system close to local conditions and assure information interaction of organs of control on various levels, provisions are made, on the one hand, for a differentiated approach to the selection of tasks, the form and content of the primary documents for each railroad by starting from its distinctive features and, on the other hand, standardization of the basic documents used for the exchange of data between subdivisions which are participating in the process of decision.

Those requirements determined the set of standard complexes of tasks which must be solved on the common information base with the use of the unified general system facilities ASUDO-D. The list of standard complexes, the sequence of their development and organization and the developers were determined by the coordination plan of development of the system approved by the Ministry of Railroads.

All complexes of tasks are interconnected technologically and with respect to information through the general system part of the ASUDO-D--a unified complex of hardware and a set of standard program and information modules which accomplish the collection of information and maintenance of a data bank on the transportation process.

The system opens up fairly broad possibilities for improvement of the control of railroad operations, permitting railroad and section management to obtain a complete idea of the operating situation on monitored sections at moments close to real time. To describe that situation to the user, the following analytical data are presented:

--shift of the freight car flows--total exchange of the railroad and sections, transfer of trains and freight cars over specific link-up points with the necessary breakdown of the pool by structure and destinations;

--the presence, dislocation and state of locomotives of the operating pool by types of traction and series on the sections and railroad, including turnaround sections, addition depots and monitored stations;

--the presence of locomotive crews for freight movement on turnaround sections and turnaround points;

--loading and unloading for the railroad, sections, monitored stations and enterprises by types of freight and freight cars;

On border railroads, in addition, similar information is issued about freight cars with export, import or transit foreign trade freight, and stations near ports and border stations are included in the monitored objects.

The possibilities of forecasting and operative planning of future work in the very near future are being especially expanded. Here one can distinguish:

--forecasting train situations and operational events--the feeding of trains and locomotives to monitored railroad stations, train formation and readiness to ship from shunting yards trains with the attachment of locomotives to them to organize train work on railroad sections;

--forecasting the arrival of goods at monitored unloading and reloading points to organize rhythmicity of the shipping work of ports, large freight stations and consignees;

--forecasting fulfilment of the main indicators of operating work--loading, unloading, transfer of trains and freight cars, the locomotive requirements, the transportation of local freight for various periods as the basis for daily-shift planning of the railroad's work;

--issuance of detailed information to operations workers about the train situation on rail sections for 3-6-hour periods, including information about assumed difficulties in operational work and recommendations on their elimination.

The system provides monitoring of the dislocation and state of individual categories of trains and separate units of rolling stock and containers, determining the location of each monitored unit, its state, the type of freight being transported, the time of shipment and arrival and the tracing of monitored points, the execution of freight and technical operations and qualitative indicators of use (the time of finding en route and during loading operations, the route speed).

A number of practical tasks of the system permit monitoring the observance of technological discipline and adopting effective measures to eliminate found violations, contributing to normal conditions of operational work:

--execution of the plan for the formation of stations;

--assurance of the formation of full-weight and complete trains;

--observance of the established procedure for direction of trains in a circuit;

--performance of regulatory tasks with elimination of counterflows of freight cars of the same kind,

The ASUDO-D assures the issuance to operations workers of stations, sections and rail administrations of a number of technological documents for each train. All results of computations are combined by the referral system, which accomplishes the necessary communications with the user. Its work consists in preparation for the railroad management of the basic services (movement, locomotive, freight, etc) and the railroad sections of the corresponding information, reports, forecasts, etc. In the first stage within the framework of the referral system summary reports are prepared in regulated conditions on movements and transport work, analytical reports for rail administrations and sections and reports for transmission to the Main Computer Center of the Ministry of Railroads. In the second stage an interactive mode of functioning of the referral system is realized, with the possibility of issuing the results of solutions of practical tasks of the ASUDO-D on displays at the request of railroad workers.

The ASUDO-D Hardware Complex

The flow of data on reception and transmission in the ASUDO-D system amounts to: from 4,000 to 1 million signs/day at the stations; $3 \cdot 10^3$ signs/day in the TCh [expansion unknown] and up to $4 \cdot 10^5$ in the NOD [expansion unknown]; up to $4 \cdot 10^5$ signs/day in mutual exchange between railroad computer centers. The total input into a railroad computer center per day in messages amounts to: full-scale sheet-telegrams, up to $3 \cdot 10^6$ signs; information about train movements for selected stations, up to $6 \cdot 10^5$ signs; information from the NOD, up to $10 \cdot 10^4$ signs; information about locomotives, up to $5 \cdot 10^4$ signs. Information is transmitted from line subdivisions over communication channels (Fig 3) directly to the computer. For that purpose in the first stage of development of the system data transmission multiplexors (MPD) are used in the following manner:

--the MPD-1 for the collection and transmission of information over telegraph communication channels and organization of referral mode through AP-64. When appropriate modifications are made, telegraphic commutatable communication channels can be connected to the MPD-1A;

--the MPD-1 (YeS-8401) for the collection and transmission of data over telegraph separated and commutable communication channels, organization of a referral mode through the AP-62 and AP-64, connection with the YeS-1010 computer over separate telephone communication channels in an asynchronous mode in accordance with exhange algorithm AP-70 (AP-1);

--the MPD-1 (YeS-8410) for reception and transmission of data over telegraph and telephone commutable and separated communication channels with use of subscriber points FKG-T50, TAP-2, TAP-3, AP-62, A-64, etc.

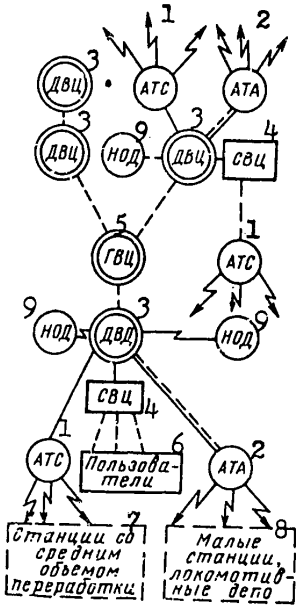

Figure 3. Structural diagram of the ASUDO-D communication system

1 -- Automatic telephone office
2 -- Automatic telephone exchange
3 -- Railroad computer center
4 -- Station computer center
5 -- Main computer center
6 -- Users
7 -- Stations with average processing volume
8 -- Small stations, locomotive depots
9 -- Railroad section chief

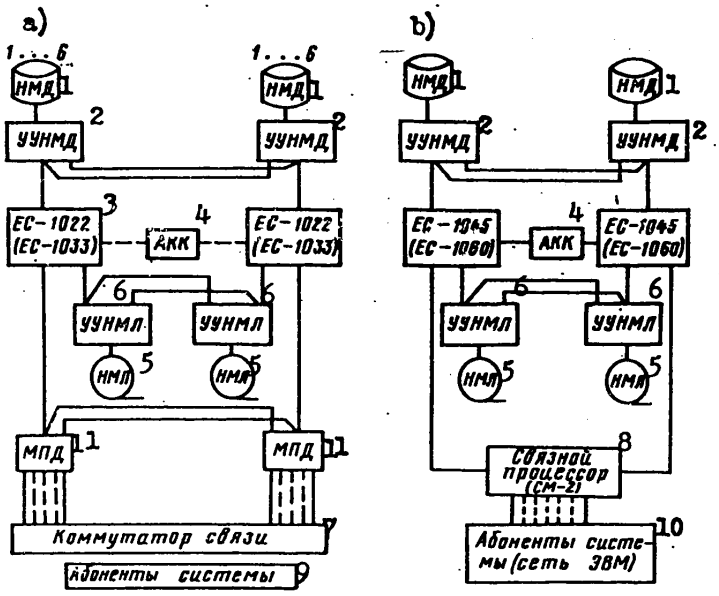

Figure 4. Structure of the ASUDO-D computer complex.

a - First stage
b - Second stage
1 - Magnetic disk store
2 - Magnetic disk store control device
3 - EC = YeS
4 - Channel-to-channel adapter
5 - Magnetic tape store
6 - Magnetic tape store control device
7 - Communication commutator
8 - Communication processor (SM-2)
9 - System subscribers
10 - System subscribers (computer network)
11 - Data transmission multiplexor

Information transmission in the first stage between railroad computer centers in the presence of various data transmission multiplexors can be done over duplex (four-wire) telegraph communication channels at 50 bits/s or with the use of an intermediate machine carrier--punched tape or magnetic tape. Subsequently the railroad computer centers must be equipped with data transmission multiplexors YeS-8410 of the same type and communication processors.

For work of the system in the first stage it is sufficient to have a two-machine complex based on the YeS-1022 (YeS-1033) computer, constructed on the level of the magnetic disk or magnetic tape store, or a "channel-to-channel" adapter (or a data transmission multiplexor to issue control signals). The main memory of each computer must be at least 512 Kbytes, and the external memory 6 YeS-5052 magnetic tape stores or 4 YeS-5061 magnetic disk stores. Figure 4a presents a structural diagram of an ASUDO-D computer complex of the first stage.

The system must be developed through increase of the computational capacity of the complex by a transition to new YeS computers of model YeS-1045 (YeS-1060) or

replacement of low-capacity processors by more powerful ones and enlargement of the main and external memories. The next stage in the development of the hardware complex and organization of exchange between machines is the introduction of communication processors based on the SM-2 mini-computer (Figure 4b presents a structural diagram of the computer complex of that stage) and message commutators. The use of communication procdssors will permit creating a uniform computer network and redistributing its resources.

The preparation and transmission of information from line subdivisions in the first stage must be done with the use of existing hardware (a T-63 teletype and Akkord-1200, TA-600, TAP-2 and TAP-3 subscriber points in a punched tape-punched tape (or magnetic tape-magnetic tape) mode. In proportion to the equipment of the railroad computer center with YeS-8410 multiplexors and communication processors the transition must be made to direct data input; in the first stage over telegraph communication channels (YeS-8401 and YeS-8410 MPD) and lager over telephone channels (YeS-8410 MPD and a communications processor).

For the organization of an interactive working mode it is advisable to use AP-62 and AP-64 subscriber points and YeS-7920 group information display equipment. In each specific case equipment must be selected by starting from the specific conditions. Thus, in the presence of communication processors based on the SM-2 for the organization of interaction it is advisable to use SM video terminal subcomplexes. At large freight stations and shunting yards the collection, preparation, processing and transmission of data must be done on the basis of mini-computers of the type of YeS-1010, YeS-1011 and SM-2. At stations which reclassify less than 30 trains per day in the first stage of introduction of the system T-63 teletypes with FKG-T50 equipment and TAP-2 and TAP-3 subscriber points will be used; in the following stage of development of the system at those stations for automation of the collection, preparation and transmission of information it is necessary to introduce intellectual terminals and micro-computers of the types "Iskra-126", "Iskra-226", SM-1800, TAP-Kh, etc. Depending on the volumes of transmitted information, the depots, sectional stations and link-up points are equipped with teletypes and TAP-2 or TAP-3 subscriber points.

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GOR'KOVSKIY RAILROAD COMPUTER CENTER FULFILLS PLAN

Moscow ZHELEZNODOROZHNYY TRANSPORT, SERIYA VYCHISLITEL'NAYA TEKHNIKA: NAUCHNO-TEKHNICHESKIY REFERATIVNYY SBORNIK in Russian No 1, Jan-Dec 81 (signed to press 3 Feb 81) pp 1-2

[Article by Ya. M. Lembrikov, deputy chief, computer center of the Gor'kovskaya Railroad]

[Text] Standing up in honor of the coming 26th CPSU Congress, the collective of the computer center of the Gor'kovskaya Railroad has assumed enhanced socialist obligations in which are envisaged further increase in the efficiency of use of computer capacities and, in particular, of the YeS-1033 computer, the use of TAP-3S equipment for transmission of information over communication channels from magnetic tape, acceleration of the start-up of the Yudino Automated Shunting Yard Control System, improvement of organization of the computational process and a further saving of punched tape, paper, red tape and other materials.

The administration and the party, trade-union and Komsomol organizations in the course of a socialist competition have devoted serious attention to increasing the reliability and the rates of organization of third-generation computers, to expansion of the use of medium-speed data transmission equipment and to increase of the rates of developments and improvement of their quality.

For 9 months of 1980 the plan tasks on problems to be solved and the volumes of information to be processed have been over-fulfilled, and labor productivity has amounted to 106 percent of the planned. The loading of "Uran-14" computers has amounted to 20.2 hours and of "YeS-1033" computers to 15.8 hours per day on the average and has exceeded the planned; the cost per hour of useful time has been reduced by 23 percent for "Uran-14" machines and by 39 percent for the "YeS-1033". In 9 months 0.4 percent of the planned wage fund was saved. The program for the development and introduction of tasks was fulfilled.

Since September 1980 the workers of the traffic and locomotive service and the management of sections and depots have have obtained by computer data on dislocations and monitoring the state of main-line diesel engines servicing the Cherusti-Druzhinino section. In that task, as in some others, use is made of apparatus transcription of the results of work of an integrated complex for processing the machinist routes on "Ural-14" and "YeS-1033" computers.

The YeS-1010 computer put in operation at the Gorkiy shunting yard and the Lyangasovo station to automate operations in processing train information in real time

are being successfully operated. At the present time those machines are connected by a direct telegraph channel over which full-scale sheet telegrams are exchanged between the machines automatically. A similar system is also being prepared for introduction at the Yudino station.

In 9 months of 1980 the computer center personnel introduced 16 rationalizers' suggestions which permitted obtaining a saving of 7200 rubles. Considerable work was done on the creation of a system for technical servicing of the YeS-1033 computer, based on the use of non-autonomous tests, which permits accomplishing maintenance, the diagnosis of faults of the input-output equipment, checking the work of equipment after it is installed or modernizing it under the control of the YeS OS operating system.

The personnel of the computer center are applying every effort to honorably fulfill the socialist pledges in honor of the coming 26th CPSU Congress.

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UDC 658.012.011.56:656.2

IMPROVEMENT OF PLANNING TECHNOLOGY AND INTRODUCTION OF AUTOMATED CONTROL SYSTEMS FOR RAILROAD TRANSPORTATION

Moscow ZHELEZNODOROZHNYY TRANSPORT, SERIYA VYCHISLITEL'NAYA TEKHNIKA: EKSPRESS-INFORMATSIYA in Russian No 2, May-Aug 81 (signed to press 29 Jun 81) pp 1-56

[Booklet entitled "Sovershenstvovaniye tekhnologii proyektirovaniya i vnedreniya ASUZhT" ("Improvement of the Technology of Planning and Introduction of ASUZhT") by A. P. Pisarev, B. M. Filimonov, N. Ye. Tarasov, et al]

[Excerpts]

Software and Improvement of the Technology of Its Development

pages 4-9

The main distinctive feature of third-generation computers is their assurance of developed operating systems which perform a large set of functions of automation of the computational process and optimization of the use of computer resources, and also the presence of translators from algorithmic languages.

Besides the YeS OS standard software the system includes the following components developed by organizations of the USSR Ministry of Railroads (MPS):

--a translator from the algorithmic language SPOK-2 [1];

--a universal set of procedures which accomplish functions of the basic YeS OS utilities;

--a program for correction of symbolic libraries with a YeS-7906 display complex and triggering of tasks for execution in a package mode;

--programs for the processing of statistical information accumulated by a systems monitor routine;

--a program for analysis of accounting information of a JOB card;

--a program for separation of a systems conclusion, one which issues at the end of a listing a line of separating symbols and the name of the user;

--macrodetermination of the structural programming in the Assembler language.

Although at the present time the YeS OS operating system version 4.1, third edition, with an executive program in the MVT mode, has been selected as the standard for MPS subdivisions, it has turned out that that system already does not satisfy the

requirements of the Railroad Computer Center and machines of the second YeS series (YeS-1035, YeS-1045, etc). The ASUZhT [Avtomatizirovannaya sistema upravleniya zheleznodoroshnym transportom--Automated Control System for Railroad Transportation] PKTB [Proyektno-konstruktorskoye tekhnologicheskoye byuro--Planning and Design Technological Bureau] considers it necessary to accomplish a transition in the very near future to work with OS 6.1.3, which in contrast with OS 4.1.3 presents the users with completely new software which offers:

--the possibility of time sharing, which permits creating, translating, editing and debugging programs in an interactive mode;

--the possibility of working in a multiprogram mode with a variable number of tasks jointly using virtual memory;

--means of regeneration for the YeS-1035 and YeS-1033 computers;

--means of grouping YeS computers.

The YeS computer software also has available large sets of standard means of realizing various functions. They include input-output generators, data base control systems and packages of applied programs to solve various standard problems.

The results of investigations conducted by the ASUZhT PKTB show that for various reasons certain standard means cannot be used to solve various ASUZhT problems. For example, the "OKA" data base control system can be used to process large data files with hierarchic and network structures of data not requiring frequent renewal, and cannot be used for tasks of operational control, whereas the "INES-2" data base control system can be used to create information and reference systems, but in that case it is required to additionally develop file maintenance facilities. Therefore together with the wide use of standard YeS computer software a need has arisen to develop our own means for the realization of various systems. Thus, in the development of a system of operational control of operating road work (ASUDO-D) [2] a need was revealed for the additional development of systems for data gathering and preliminary processing, the servicing of files, control of the computational process, and special software for the description of information and reference systems (a data description language and a calculation description language). In the process of development of an information and reference system for the ASU of the Railroad Economy a system was created for the processing and issuance of output forms. In that case it should be noted that the modules developed for certain systems in a number of cases are becoming universal and can be applied in many developments. Thus the file maintenance system has already found application in the system of integrated processing of a road record and in the DISKOR road level system; it can also be used in many other problems. The system for the processing and issuance of output forms, which has been formulated as a package of applied programs and is used by many organizations of the MPS and other departments as a means of the technological engineer for obtaining successful materials, has also become widespread in use. Very great acknowledgment has been obtained by the system for data gathering and preliminary processing, which has been officially approved as the basic system for remote data processing in the ASUZhT and is open for further development.

The subsequent development of the ASUZhT within the framework of the organization of the computer network requires the creation of data exchange between machines

for the purpose of assuring its efficiency and reliability for use on different levels and the exclusion of mechanical data carriers, which leads in the final account to the combining into a single whole of all railroad computer centers of the railroad network and to the creation of a so-called distributed computer network. This will permit not only solving the problem of data exchange but also using available computer capacities very completely and uniformly.

The problem of creation of such a network at the present time requires selection of a universal and flexible algorithm for exchange between computer complexes on the level of control of the channels for transmission of data to the data transmission system, for known algorithms for exchange between machines (exchange protocols) developed within the framework of protocol X.25 upon the recommendations of the International Consultative Committee for Telephony and Telegraphy such as ANSI, SDLC, HDLC, etc, have neither software nor hardware capable of realizing them. In the PKTB ASUZhT a detailed analysis has been made of all existing exchange algorithms capable of becoming universal and not limiting the development of the network, as a result of which an exchange algorithm of the type of AP-70 has been selected, which has been technically realized in all types of YeS computer data transmission multiplexors and has a number of advantages important and necessary for the organization of a computer network:

--the possibility of organizing conditions of "rivalry";

--the presence of program support in all OS versions under control of the VTAM and TSAM methods of access;

--the use of asynchronous exchange conditions with the KOI-7 exchange code and rates of data exchange of 100-1200 bits/second over telephone and telegraph channels of communication.

The adopted algorithm for intermachine exchange of type AP-70 was realized in the PKTB ASUZhT during organization of the interaction of the YeS-1030 computer and the MPD-1A (YeS-8400) with the YeS-1010 computer [3]. Additionally for the realization of exchange the macrocommands READTV, READTB and WRITETL were developed; they have been included in the BTAM program resources. Distinctive features of the realization of that algorithm for intermachine exchange are:

--the introduction into the algorithm of priority timing for successful expansion of conflict situations during simultaneous initialization of a call from both sides (3 s for the YeS-1030 and 20 s for the YeS-1010);

--the establishment of communication, accomplished by means of a set of service symbols identical to the symbol "Who is there?", presented in the form of the combination "NT-NT-KP-KT" (NT--start of text; KP--end of transmission; KT--end of text, in accordance with the KOI-7 code table);

--confirmation of reception, accomplished by the combinations "YES-YES-KP-KT" or "NO-NO-KP-KT" (YES--symbol of a positive reply; NO--symbol of a negative reply). When a negative reply has been obtained, transmission of the data block is repeated three times;

--conclusion of the communication, accomplished by means of transmission of the combination "YES-YES-KP-KT".

Results of the work show that the application of the given algorithm for intermachine exchange is very realizable in the ASUZhT from both the hardware and the

software points of view on its different levels--"Main Computer Center-Railroad Computer Center", "Railroad Computer Center-Railroad Computer Center", Railroad Computer Center-ASU SS", etc.

The creation of the computer network in the future will require detailed consideration of problems in organization of the computational process, and protection against unauthorized access, and also problems of the technology of system planning.

Contemporary requirements for software presuppose a high technical level of the organization of its planning. On the agenda stands the question of transforming a program into an article of the industrial type, satisfying certain standards, and readily corrected and maintained. In that direction the PKTB ASUZhT has been doing some work, including:

--study of the leading technology of planning on the basis of available translated and Soviet literature, and also experience of other organizations;

--analysis of labor productivity during the performance of planning work by programmers, and the revelation of reserves and directions of application of the leading technology;

--the development of planning standards;

--teaching of advanced programming technology and the organization of planning;

--study of experience in the introduction of leading methods of planning and the development of corresponding methodical materials for the Railroad Computer Center.

One element of advanced technology is the introduction of standards of modular programming. Such requirements for the construction of a program complex as the presence of a single executive routine with a common working field for all other programs, a standard input and output for each module and limitation on the module length are justified and are already used by the leading programmers. The following stage was the introduction of structural programming. Modular and structural programs are creating the basis for a new approach to the organization of planning --so-called planning from the top down [4]. This method requires, primarily on the part of the manager, through understanding of the problem and much preparatory work for direct programming and debugging (breakdown of the task into parts forming the standard structures, the plan for testing and debugging, solution of the question of the possible deviations from an ideal circuit, etc).

Planning from the top down must be introduced into both the hardware and software sections. Substantial support for the introduction of that method is the HIPO technology, which gives rules for documentation of the program and assumes in that case use of the method of planning from the top down.

The enumerated methods of programming and planning are not the only ones. At the present time it is important to study already existing experience in their use and to make it a general achievement.

Of no little importance in increasing the productivity of computers and developers is the system of organization of debugging work. Used as the basic system in the PKTB ASUZhT is the package method of processing tasks in a multiprogramming mode.

Work has been done recently on the search for improved program debugging modes. The systems "Interactive remote introduction of tasks" and "Time sharing system" have been tested; "Correction of starting texts and triggering of tasks for execution with the YeS-7906 display complex" has been operated experimentally. The results of that work showed that at a computer installation with a small number of direct-access equipment and controls for them, a small main memory of the computer, small speed of the processor and, what is the most important, when one encounters unstable work of the computer, the application of means of remote debugging does not bring perceptible effect.

Of the above-enumerated systems, "Time sharing system" has proven to be the most effective, but for its application it is necessary that the computer have a main memory of at least 1 Mbyte.

The ASUZhT software is subdivided into general-system and applied; the applied software is based on the general-system, which performs general functions--input, output, data bank maintenance, intermachine information exchange, etc. The applied performs functions of ASUZhT functional tasks. In the development of these two parts of the software it is necessary to use improved methods of programming--the HIPO technology and modular and structural programming. Such an approach to development will permit considerably reducing the time required for the development and introduction of a system, on the one hand, and will permit standardizing the computational process in railroad computer centers, on the other. An example of that is the development of the ASUDO-D system.

ASUZhT Hardware and Distinctive Features of Its Planning

Pages 28-32, 34-39

The planning of the hardware of the first ASU line was done by each railroad individually, as the hardware products list was limited, the systems developed on the different railroads were poorly connected with respect to information, the functioning of tasks was accomplished in a package mode, and the exchange of information between the railroad computer center and the information points, as a rule, did not provide for remote processing.

The ASUZhT second line required a different approach to hardware planning, for the basis here was problems to be solved in real time, an extensive hardware products list requires the development of standard general-system software, and remote processing is the basic regime of information exchange. The close informational interconnection between the processing complexes of different levels required solution of the problem of intermachine exchange, and on the scale of the network, the creation of a branch computer network. Another important factor which influences the approach to hardware planning is the requirement of maximum compatibility of the process of primary document preparation with the obtained information on machine carriers.

All this taken together required a complex approach to the planning of the technical base--from the information sources to the processing complexes. On the other hand, to assure the effective use of hardware it is necessary to take into account distinctive features of each object, that is, to assume their definite individualism, which can be solved by standardization of planning decisions for different

levels and as a function of the assumed volumes of information. Such an approach permits reducing to a minimum labor expenditures in the planning of both hardware and software and creating unity of technology and technical policy in the branch.

Soviet industry and the industry of the CEMA member-countries has organized and is now issuing an enormous arsenal of computer hardware, starting from powerful computers of the YeS-1060 type to micro-computers and information registers. One of the main tasks in the construction of an automated control system for railroad transportation is growth of the capacity of resources for the automation of the gathering, preparation, primary processing and transmission of information with the use of microprocessor technology. It will permit increasing the number of users of the system, contructing a more reliable model of train position, maximally automating data processing in the field, increase the efficiency of use of communication channels and reduce their total number. One of the variants of the structural scheme of an ASUZhT hardware complex is presented on Figure 2. It is assumed that the ASUZhT will have a four-level system (the Main Computer Center of the Ministry of Railroads, the Railroad Computer Center, junction or station computer centers and the ASU of Line Subdivisions, such as sectional, intermediate and freight stations, link-up points, locomotive and freight car depots, etc).

Hardware Complex of the Main Computer Center and the Railroad Computer Center

To solve the complex of problems determined by the technical assignment on the second line of development of the ASUZhT it is necessary to gather information from more than 300 subscribers. The volume of arriving information from a single subscriber amounts to from a thousand (path distances, structural controls, etc) to a million signs per day (shunting stations, large locomotive depots, freight stations). Even today many railroad computer centers are processing a flow of information that exceeds several million signs per day. By 1990 that flow will amount to from 10 to 30 million signs per day, and some railroad computer centers will surpass that level. At such an input the computer capacity for the reception, processing and issuance of information must amount to from 0.6 to 2 million operations per second. Input-output information must be produced over commutatable and separated telegraph and telephone channels of communication with the use in the first stage of an MPD-1 data transmission multiplexor (YeS-8410) and a YeS-1022 (YeS-1033) computer. The information will be processed as a function of its volume on a YeS-1035, YeS-1045 or YeS-1060 computer. Presented in Table 1 is the make-up of type YeS computers in railroad computer centers as proposed by the PKTB ASUZhT as a function of the volumes of input information to be processed.

Table 1 Make-up of Computers in Railroad Computer Centers

Volume of input data, million signs per day	Type of YeS Computer			
	1022	1033 (1035)	1045	1060
Up to 10	2	2		
Up to 20	2		2	
Up to 30		2	2	
Over 30		2		2

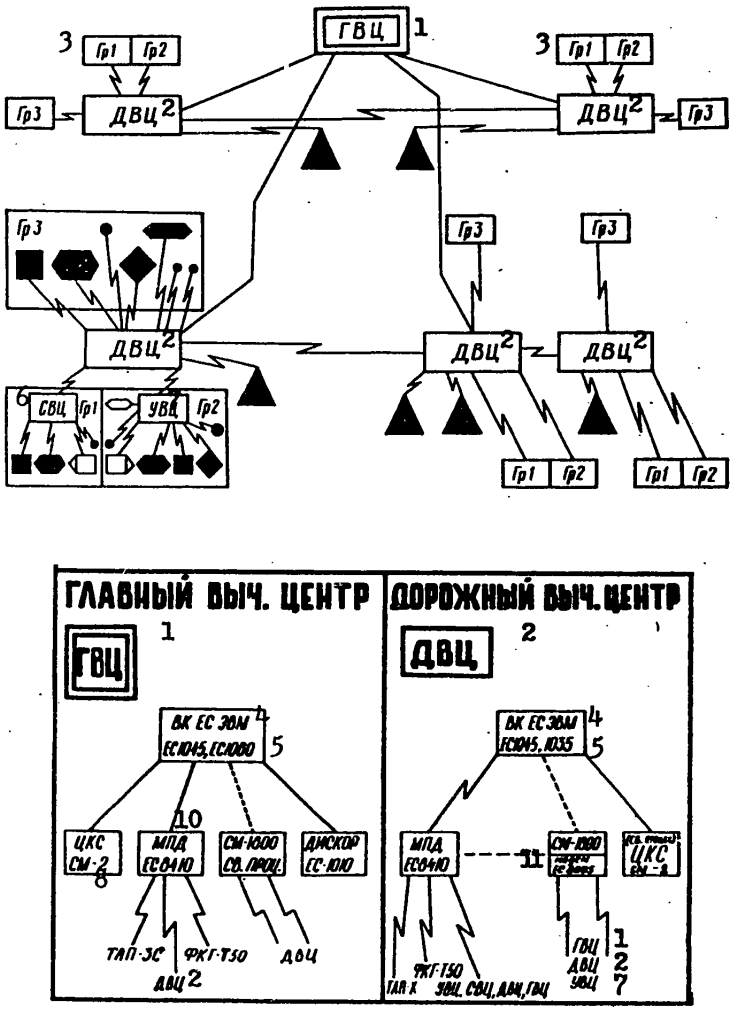

Figure 2. Structural diagram of the ASUZhT hardware co,plex.

1 -- Main Computer Center
2 -- Railroad computer center
3 -- Gr-1
4 -- Computer complex of YeS computers
5 -- EC = YeS
6 -- Station computer center
7 -- Junction computer center
8 -- SM = Small Computer
9 -- System subscribers
10 -- Data transmission multiplexor
11 -- Modem
12 -- Shunting station with capacity of 50 trains per day
13 -- Link-up point
14 -- Freight stations
15 -- Separate railroads

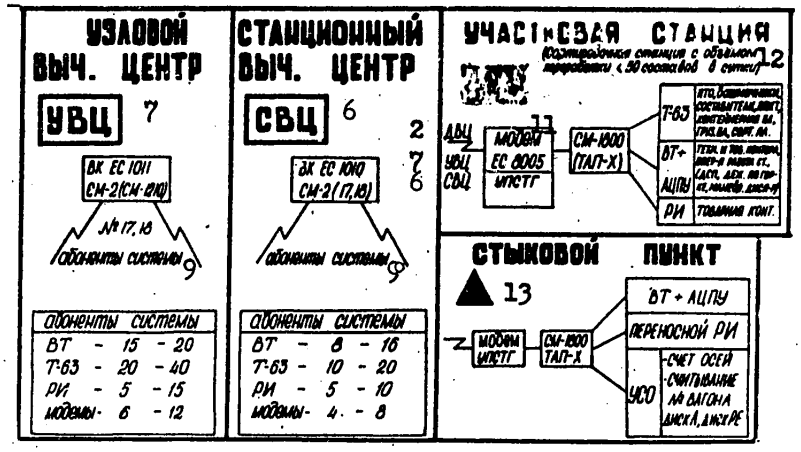

Figure 2. (Continued)

16 -- Locomotive and freight car depots
17 -- Sectional and industrial stations
18 -- Capaciiy of 25 freight cars per day
19 -- Small stations
20 -- Punched tape
21 -- Communication channel
22 -- Goods office
23 -- Data register

The total memory capacity for a railroad computer center must amount to 200-400 Mbytes, of which the capacity of the stores of direct access (the magnetic disks) is 100-300 Mbytes; the capacity of the main memory is 3-6 Mbytes. Virtual memory must be used in the real time mode. The computers are grouped on the basis of a common magnetic disk store and "channel-channel" adapters. The interactive working mode is constructed on the basis of AP-62 and AP64 subscriber points and YeS-7920.11 group information displays. The following stage in the development of the hardware complex and the organization of the Ministry of Railroads computer network is the introduction of connected processors and message commutators based on SM-2 mini-computers.

Junction Computer Center and Station Computer Center Hardware Complexes

The main requirements presented for hardware complexes for station and junction computer centers are:

--the possibility of work in real time and a developed system of remote processing;

--the possibility of performing the functions of monitoring and control of technological processes;

--the possibility of increasing computational capacity.

These requirements are satisfied very completely by the Soviet SM-2 computer and by the YeS-1010 and YeS-1011 of Hungarian origin.

In the Eleventh Five-Year Plan it is proposed to conduct an experimental operation of the SM-2 computer in the ASU SS system. A two-machine specialized control computer complex (SUBK No 17 and 18) has been ordered for that purpose; it has the following parameters:

--a main memory capacity of 256 x 2 Kbytes;

--a magnetic disk storage capacity of 60 x 2 Mbytes;

--a magnetic tape storage capacity of 30 x 2 Mbytes;

--up to 48 connected commutatable telegraph channels;

--up to 22 sets of video terminal systems equipped with DZM-180 alphanumeric printers or magnetic tape cassette stores, with a maximum distance between the pair of telephones of 16 km;

--up to 4 sets of video terminal systems connected at a distance of over 16 km.

All the communication modules are connected to the computer through a multiplex interface splitter, working in automatic and semi-automatic conditions of switching communication channels from one computer to another, and the computers themselves are grouped into a single computer complex on the level of the processors. The productivity of the computer complex based on the SM-2 is increased by increasing the number of connected computers or processors. The YeS-1011 computer is a later model of the YeS-1010 computer; it has a greater speed, an expanded memory (to 1 Mbyte) and six permanent magnetic disk stores with a capacity of 2.5 Mbytes each; in addition, the YeS-1011 is capable of grouping two computers by organizing a common memory field on the basis of the main memory and magnetic disk stores.

Users of junction or station computer centers more than 16 km distant (for the SM-2) or 5 km distant (for the YeS-1011) must be connected with the use of micro-computers or intellectual subscriber points of the type of TAP-Kh or SM-1800.

Hardware Complex of Line Subdivisions

Of the entire set of micro-computers, subscriber points and data registers developed and organized by industry for purposes of the automation of the gathering, preparation, primary processing and transmission of information the requirements of the Ministry of Railroads are satisfied most completely in the present stage by the micro-computers SM-1800, TAP-Kh and "Iskra-554" (or "Iskra-555"), the data registers RI7501b, RI7801, RI6402, RI6401 and RI2401 and the subscriber points TAP-ZS, FKG-1001, FKG-T50 and T-63. This hardware can be installed at sectional, freight and intermediate stations, etc. The quantity of hardware installed and its structure depend on the volume of work of the given subdivision. When the volumes of information to be processed are considerable, arrangement of the hardware with separation of the control functions is possible--thus, for example, for a sectional station with a large volume of freight work it is advisable to introduce an ASU for a goods office, an ASU for a technical office and to install a model SM-1800 central micro-computer into which the resulting information arrives from the two ASU's and which accomplishes functions of communication with the station, junction and railroad computer centers. Subscribers of sectional, freight and intermediate stations, link-up points and others are equipped with video terminal systems, data registers and teletypes and are connected to that micro-computer over physical lines. Additionally connected by an object communication device are systems for information readout from rolling stock and axle counters, and the ASU of the shunting station is also connected; it has gravity yard automatic centralization with monitoring of breakup, similar to what has been done at the Shkirotava station, for automatic removal of information about the actual breakup of a train. Several variants of hardware complexes are suggested for the creation of an ASU of linear subdivisions:

a) installation of a YeS-1800 computer in groupings of three types:

--two SM-1800 computers connected by a connection module (US SM), each of which has a main memory with a capacity of 64 Kbytes, two floppy disk stores (NGMD), three video terminals (VTA), three model DZM-180 alphanumeric printers (ATsPU), two modules for connection with a modem (MSM) and five modules for connection with a teletype (MST).

--one SM-1800 computer with a main memory capacity of 64 Kbytes, one NGMD, 2 MSM, 1 MST, two VTA, one DZM-180 and four object communication devices (USO);

--two SM-1800 computers, each of which has a main memory capacity of 64 Kbytes, one MSM, one NGMD, one VTA, one DZM-180 and 8 USO;

b) installation of a TAP-Kh, which is an intellectual terminal constructed on the basis of a microprocessor and has a main memory with a capacity of 32 Kbytes, two NGMD, one VTA and 1 MSM;

c) installation of RI2401, RI6401, RI6402, RI7501 and RI7801, the principal technical characteristics of which are presented in Table 2.

Table 2 Principal Characteristics of Data Registers

Characteristic	Data Register Model				
	2401	6401	6402	7501	7801
Data input:					
from keyboard	num	num	al/num	al/num	al/num
from punched cards	yes	yes	yes	yes	no
Indication	16-digit	16-digit	-	num	CRT
Printer	no	MP-16	"Konsul"	DARO al/num	"Konsul"
Transmission speed over communications channel, signs/s	200	200	200	1200-9600	1200-2400
Magnetic tape cassette store	no	no	no	yes	yes
Control	computer	computer	computer	program	program

Computing and Data Processing Computer Network

The computing and data processing computer network in railroad transportation must be created on three main levels--the functional, commutation of messages and commutation of channels. In the given stage of the creation of an ASUZhT the last-mentioned is the most developed.

The creation of a computer network in the full volume of its functioning is an extremely difficult and costly task, but it is greatly simplified if the network is created with only the functions most necessary for the Ministry of Railroads, that is, with well-developed informational and less developed computational functions. This network must be created simultaneously also as a departmental autonomous network and as a component part of the statewide automated system for collection and processing of information for accounting, planning and control in the national economy with consideration of all the effective normative documents, including the international (documents of the CEMA, the International Consultative Committee of Telegraphy and Telephony, etc).

Such a network must have the following properties:

--computers in the network correspond automatically with one another;

--the work of the network is assured by a distributed operating system which belongs to a family of network operating systems, being an expansion of local operating systems without change of the latter. This permits using one and the same program interfaces of tasks in working in network conditions and during local work;

--regulation of the architecture and characteristics of the network is established by a hierarchy of protocols which determine the procedures of computer interaction

on various levels, starting with the physical interface of communication channels and ending with the level of information exchange between remote information processes and remote tasks;

--the main part of the network resources (processor, communication, etc) is expended on the accomplishment of dispatcherization, routing of messages, diagnosis, network measurement, adaptation to varying conditions of network functioning, etc. The generation of that part of the resources (about 80 percent) in the ASUZhT can be possible only when relatively inexpensive computer hardware (mini- and microcomputers) is used.

The SM-2 grouping recommended by the PKTB ASUZhT (specialized control computer complexes Nos 17 and 18) is designed for work under network conditions, and so even at the present time it is possible to create experimental computer networks based on unification of the ASU SS on a certain polygon of the railroad network.

The created experimental computer network in the general case can be classified according to three groups of signs--the structural, functional and purpose. The main structural signs of a network are the topology, the method of dispatcherization of work to the network computer center (centralized, decentralized or combined), and the make-up of the computers (uniform or non-uniform). Developments made in the PKTB ASUZhT have shown that an experimental network created on the basis of SM-2 computers must have a radial-circular topology with a centralized type of dispatcherization, which greatly simplifies conducting the experiment.

In the first stage it is advisable to include only SM-2 computers (but not more than 30 groups), as the realization of communication and interaction between the processes of processing in a remote computer is very complex for non-operating works, that is, networks consisting of computers with different structural and functional characteristics (word length, operating systems, data organization, interruptions, etc), and is simplified for networks constructed on the basis of computers of the same type.

According to their functional purpose computer networks are divided into the informational, computational and computing and data processing. A computer network combining station computer centers (ASU SS) ought to primarily have an informational character. It is created to obtain the possibility of more efficient movement of information for great distances by means of a complex system of exchange protocols, which must:

--determine the physical connections with communication channels;

--include agreements relating to the semantic content of the control information;

--describe algorithms for exchange between various elements of the network;

--assure the detection and correction of errors;

--describe methods of routing messages;

--control buffer pools and message lines;

--assure reliability of information exchange.

Protocols must be quasi-independent, that is, each of them must regulate independent exchange between network elements only on its own level, but at the same time the realization of the protocol of each level must be based on protocols of lower levels. The lower levels of protocols, called the physical interface, must in accordance with the effective standards characterizing the physical connection of the communication channels, correspond to the requirements of the International Consultative Committee of Telegraphy and Telephony.

The communications equipment which assures a low level of protocols in the SM-2 include the following data transmission equipment:

--a duplex register--a module which assures parallel data exchange between computers up to 50 m apart;

--an intrasystem communications module, which assures consistent data exchange by cable at a distance of up to 3 km;

--an APD-MA [data transmission device]--apparatus which assures communication over standard telephone communication channels;

--an APD-MPP--apparatus for multipoint connection of equipment or computers at a distance of up to 16 km apart;

--a module for connection with telegraph channels;

--sets of coupling modules with C1, C2, C3 and C4 couplings.

In creating a Ministry of Railroads computer network it is necessary to combine computers of three different classes--maxi-, mini- and micro- into a single system which performs all the set of algorithmic acts necessary within the framework of the ASUZhT.

We classify as "maxi-computers" all YeS computers (except YeS-1010 and YeS-1011); as "mini-computers", YeS-1010 and YeS-1011 computers and all SM computers except SM-1M and SM-1800. For the class "micro-computers" in the Ministry of Railroads network, RPT, SM-1800, SM-1M, VTS-56100 and TAP-Kh have been specified.

Mzxi-computers are used in powerful functional systems of the ASUDO-D type as information processors working under the control of a communication processor. In the railroad computer center several information processors are basic, and the rest duplicate them. The principal questions for the given class of computer are questions of the linkage and use of a local operating system by creating functional superstructures (monitors).

Mini-computers are used in medium-sized functional systems (of the ASU SS type) as information processors working under the control of the railroad computer center and communication processors, and also for the creation of message commutation centers. It is most advisable to realize the communication processers on two-processor computers of the SM-2 type.

It is advisable to use micro-computers in small systems (subsystems) as communication or terminal processors.

In the creation of an experimental computer network it is necessary to take into consideration that at the present time in our country a single methodology for

the planning of computer networks has not yet been created, and so a methodology of planning the ASUZhT computer network represents a fairly large and independent problem.

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PERSONALITIES

COMPUTING MATHEMATICS, CYBERNETICS FACULTY DEAN TIKHONOV'S WORK HONORED

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: VYCHISLITEL'NAYA MATEMATIKA I KIBERNETIKA in Russian No 3, Jul-Sep 81 pp 3-8

[Article: "In Celebration of the 75th Birthday of A.N. Tikhonov"]

[Text] One of the greatest scientists of our time, Academician Andrey Nikolayevich Tikhonov, was born on 30 October 1906 in the city of Gzhatsk in Smolenskaya Oblast (now the city of Gagarin).

In 1922 Andrey Tikhonov finished secondary school as an external student and entered the mathematics department of the physics and mathematics faculty of Moscow University and in 1927 he completed the university and entered as a graduate student the Moscow University Institute of Mathematics.

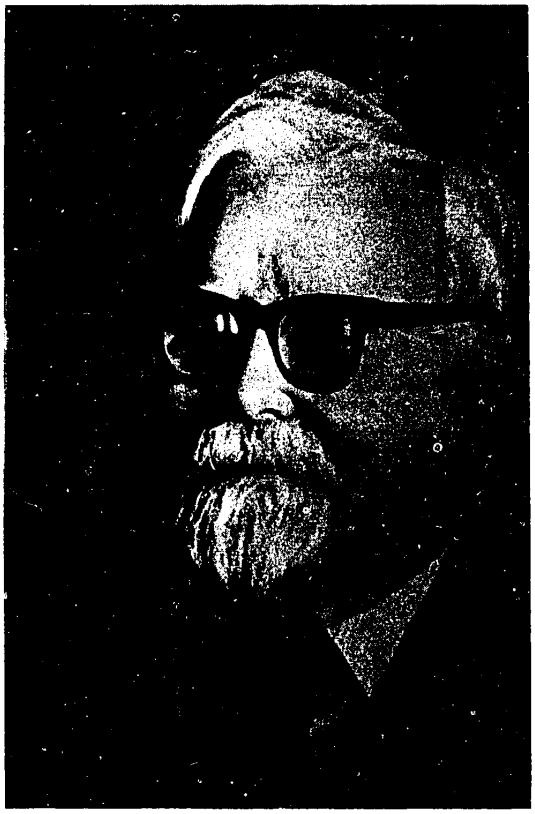
A.N. Tikhonov has been a professor at Moscow University since 1936 and in 1937 he was elected a corresponding member of the USSR Academy of Sciences. In 1953 A.N. Tikhonov was given the title of Hero of Socialist Labor and was awarded the first-degree USSR State Prize. In 1966 A.N. Tikhonov was elected a full member of the USSR Academy of Sciences. He was awarded the Lenin Prize in the same year. In 1976 A.N. Tikhonov became the winner of still another USSR State Prize.

At the present time Academician A.N. Tikhonov is the dean of the faculty of computing mathematics and cybernetics at Moscow University and heads the department of computing mathematics in this faculty. The faculty was created in 1970 with the very active and decisive participation of Andrey Nikolayevich. Andrey Nikolayevich has been the unquestioned director of the faculty since the instant of its creation. The development of the faculty of computing mathematics and cybernetics over the last 10 years and the great achievements of the faculty's team in the area of training a broad range of specialists and of constantly improving the efficiency of scientific research have been constantly associated with the work of Andrey Nikolayevich, who has directed the team's efforts at the solution of timely problems.

At the same time A.N. Tikhonov is the director of the USSR Academy of Sciences Institute of Applied Mathematics imeni M.V. Keldysh.

Andrey Nikolayevich was the initiator of the creation in universities of the Soviet Union of faculties of computing and applied mathematics, where specialists are trained not only in the area of studying mathematical models of various natural

science problems, but also in the area of computing complex software, automated control and planning systems, and systems for processing the results of complicated scientific experiments.



Andrey Nikolayevich Tikhonov

In beginning to characterize the creative scientific work of A.N. Tikhonov we immediately note the quite extensive range of his scientific achievements. The fundamental pioneering results in many areas of modern mathematics and its applications (topology and functional analysis, theory of differential equations,

computing mathematics and mathematical physics, the construction and study of mathematical models of various natural science problems) are those of A.N. Tikhonov. A.N. Tikhonov has made an enormous contribution to the creation of new scientific trends such as methods of solving incorrect problems, the automation of scientific research and the development of systems for the automated processing of the results of complicated scientific experiments. To this must be added the fact that the creative scientific work of A.N. Tikhonov represents a distinct and rather rare example of a combination of first-class achievements in the most abstract areas of "pure" mathematics and the profound investigation of applied problems directly related to the requirements of practical work.

The earliest period of the creative scientific work of A.N. Tikhonov was devoted to topology and functional analysis. As an 18-year-old youth Andrey Tikhonov obtained his own first results--a proof of the fact that any regular topological space with a denumerable base is a normal space (and therefore also metrizable). Two years after this the young scientist published the results which brought him worldwide fame and which placed him among the outstanding topologists of our time. First Andrey Nikolayevich formulated a definition of the topological product of any set of bicompact spaces. In mathematics finding the correct definition rather often plays a decisive role in the entire theory. Tikhonov's definition of the product of topological spaces plays just such a decisive role in topology.

On the basis of this definition A.N. Tikhonov proved that the product in his sense of any set of bicompact topological spaces is also a bicompact topological space. "Tikhonov topology," based on this definition, has firmly entered the arsenal of fundamental concepts of modern mathematics. The topological work of Andrey Nikolayevich is the foundation for all modern topology, for the theory of topological groups, for the theory of dynamic programming and for a number of divisions of functional analysis.

Then A.N. Tikhonov worked on the general theory of differential equations and on studying problems of geophysics and electrodynamics which are important from the application standpoint.

Prominent Topologist A.N. Tikhonov became a world-famous specialist in the general theory of differential equations and in topical problems of geophysics and electrodynamics.

The first studies of A.N. Tikhonov on the theory of partial differential equations were the result of his studying a number of topical problems in geophysics, in particular, the problem of reconstructing the historical climate of the earth. In studying these problems A.N. Tikhonov formulated and solved a number of fundamental general mathematical problems.

A striking example of the solution of such a fundamental general mathematics problem is A.N. Tikhonov's study (1935), which has now become a classic, in which he found in a specific sense the definitive conditions guaranteeing the existence and uniqueness of a solution to Cauchy's problem for the heat equation.

These conditions, which consist of the requirements for continuity of initial function $u_0(x)$ and of the existence of a limit

$$\lim_{|x|\to\infty} [u_0(x)\cdot e^{-c|x|^2}] = 0,$$

are now customarily called Tikhonov's conditions.

The ideas set down in this study by A.N. Tikhonov were developed in subsequent years in studies by a number of Soviet and foreign mathematicians (O. Vider, O.A. Ladyzhenskaya, O.A. Oleynik, I.M. Gel'fand and G.Ye. Shilov, etc.). Then Andrey Nikolayevich formulated and studied the inverse heat problem. He proved the fundamental theorem that the solution, $u(x, t)$, of the heat equation in region $x > 0$, $-\infty < t < t_0$, is unambiguously determined from the assigned value of $u(x, t_0) = u_0(x)$, if only a single derivative of this solution is limited in terms of coordinate.

Belonging to the same period of work is A.N. Tikhonov's fundamental study on the congruence of regions for which the first boundary problem for the heat equation and the Dirichlet problems for Laplace and Helmholtz equations are solvable in the classical sense. Having determined the fundamental region as that for which the individual problem is solvable in the classical sense, A.N. Tikhonov proved the following three statements: 1) any bounded region fundamental for the heat equation is a fundamental region also for the Laplace equation, 2) any region fundamental for the equation $\Delta u - \lambda u = 0$ with some $\lambda \geq 0$ is a fundamental region for the equation $\Delta u - \lambda u = 0$ with any $\lambda \geq 0$, and 3) any region fundamental for the equation $\Delta u - \lambda u = 0$ with any $\lambda \geq \lambda_0$ is a fundamental region for the heat equation, too.

These studies by A.N. Tikhonov were continued in later years by a number of mathematicians: In 1949 O.A. Oleynik and G. Tautts proved that the region fundamental for the Laplace equation is also fundamental for a general second-order elliptic function with sufficiently differentiable coefficients; in 1959 V.A. Il'in proved that a cylindrical region is the fundamental one for second-order hyperbolic and parabolic equations permitting the Fourier method any time when the cross section of this cylindrical region is the fundamental region for a Laplace equation.

These studies by A.N. Tikhonov were continued subsequently by V.R. Nosov, S.M. Ponomarev, A.A. Novruzov, etc.

Affiliated with A.N. Tikhonov's cycle of studies on partial differential equations is also his doctoral dissertation, defended in 1936, in which the concept of a functional equation of the Volterra type was introduced and a study was made of the conditions for the applicability of the method of successive approximations of Picard and of the Cauchy-Lipschitz method of polygonal approximations for solving this equation. A number of problems for the heat equation were discussed as applications, in particular the problem of the cooling of a solid with emission from its surface following the Stefan-Boltzmann law. These results of A.N. Tikhonov were utilized considerably by V.G. Fesenkov in investigating the properties of the surface of the moon.

Then A.N. Tikhonov constructed the strict mathematical theory of a thermocouple, studied the influence of radioactive decay on the temperature of the earth's crust,

developed the theory of electromagnetic methods of studying the earth's crust and mantle (and, in particular, methods of prospecting) and provided theoretical justification for using the natural electromagnetic field of the earth for obtaining a complete electrical cross section of the earth's crust.

Let us emphasize that in studying these problems a fundamental role was played by the problem, developed by A.N. Tikhonov, of the stability of inverse problems.

For the purpose of proving the uniqueness of the range of inverse problems considered, A.N. Tikhonov formulated and solved the problem of the possibility of determining coefficient $q(z)$ in equation $u'' + \lambda q(z)u = 0$ with the condition $u(\infty) = 0$ from the assigned function

$$f(\lambda) = \frac{u'(0, \lambda)}{u(0, \lambda)}.$$

He proved the uniqueness of the definition of this coefficient, $q(z)$, in a class of complex values of spectral parameter λ under the assumption of the piecewise analyticity of $q(z)$.

Now after the lapse of a number of decades it is impossible not to note that in this cycle of studies by A.N. Tikhonov fundamental mathematical results were obtained for the first time relating to the problem of reconstructing a linear differential operator from the properties of its spectrum. These results preceded the familiar studies of I.M. Gel'fand, M.G. Kreyn, B.M. Levitan and V.A. Marchenko.

A.N. Tikhonov completed a cycle of studies on electrodynamics in conjunction with A.A. Samarskiy. Mention should be made especially of two studies, in the first of which the general method of constructing a Green's function for a system of Maxwell equations in a cylindrical region with a random cross section was validated, and in the second the principle of a limiting peak value was formulated and studied, i.e., the question of defining a unique solution, $u(x)$, to the Helmholtz equation in an unbounded region as the limit as $t \to \infty$ of the solution, $u(x, t)$, of the corresponding Cauchy problem for the wave equation.

These studies by A.N. Tikhonov and A.A. Samarskiy were continued in the studies of A.G. Sveshnikov, O.A. Ladyzhenskaya, V.M. Babich and other mathematicians.

A.N. Tikhonov was also involved in studies of the mathematical theory of chemical processes, in particular, studies completed in 1945-46 devoted to the dynamics of sorption. The timeliness of these studies consists in the fact that they comprise the theoretical basis for the design of various decontamination facilities, whose importance has been increasing steadily in connection with the problem of environmental protection. The mathematical model of this range of problems has resulted in nonlinear systems of partial differential equations. Andrey Nikolayevich has found precise analytical solutions for some of these problems and for other problems which are not subject to an analytical solution he has used the method of combining numerical and asymptotic methods. At the present time this cycle of studies is being continued successfully by A.V. Lukshin.

A.N. Tikhonov's great merit lies in the fact that he was the first to formulate and begin to study in 1948 the question of the behavior of solutions of systems of ordinary differential equations with a perturbation with the highest derivative. For systems of the type

$$\begin{cases} \dfrac{dy_i}{dt} = f_i(t, y, z) & (i = 1, 2, \ldots, n), \\ \mu_j \dfrac{dz_j}{dt} = F_j(t, y, z) & (j = 1, 2, \ldots, m), \end{cases}$$

in which μ_j are perturbations satisfying the condition $\mu_{j-1} \leq \mu_j$ and are such that as $\mu^j \to 0$ there exists a limit to the ratio $u_{j+1}(\mu)/\mu_j(\mu)$, Andrey Nikolayevich provided a general formulation for the Cauchy problem and established the criteria upon the fulfillment of which solutions of the initial system tend to the solution of the singular system as perturbations tend to zero.

These studies by A.N. Tikhonov, which formed the bases of a scientific trend under heated development at the present time--the theory of singular perturbations--have been continued by his students and other mathematicians, among whom should be mentioned primarily A.B. Vasil'yeva and V.F. Butuzov, V.M. Volosov, Ye.F. Mishchenko and N.Kh. Rozov, S.A. Lomov and many others.

A.N. Tikhonov has also made an enormous contribution to the development of modern computing mathematics and mathematical physics. Finite difference methods represent some of the most effective methods of solving boundary problems for complicated systems of differential equations. A.N. Tikhonov in cooperation with A.A. Samarskiy created the theory of homogeneous difference systems designed for solving classes of problems definable by assigning only the type of differential equation and boundary conditions. They also formulated and proved the principle of the conservatism of random homogeneous difference systems as the necessary condition for convergence of the system in a class of discontinuous coefficients. The theory of homogeneous difference systems has received further development in studies by A.A. Samarskiy and his students.

Characteristic of the creative scientific work of A.N. Tikhonov is the fact that together with the intense study of fundamental mathematical problems he has formulated and solved a number of problems which are of important national economic significance. A great number of efficient algorithms for solving quite diverse problems in electrodynamics, geophysics, plasma physics, gas dynamics, the dynamics of sorption and other fields of natural science have been created under his guidance and with his direct participation and have been utilized in practice.

The team headed by A.N. Tikhonov and A.A. Samarskiy, as the result of studying the process of the expansion of a plasma column in a magnetic field by means of methods of mathematical modeling utilizing a computer, has discovered a new physical phenomenon--the formation of a high-temperature layer of plasma, which has been given the name the "T-layer effect." This theoretically established effect, which has been registered as a discovery, has subsequently received numerous experimental confirmations.

One more of the most brilliant achievements of modern mathematical science belongs to Andrey Nikolayevich--the method, developed by him, of a firm solution to broad classes of incorrectly formulated problems. These studies by A.N. Tikhonov have defined a new trend in mathematics involving a fundamentally new approach to the problem of utilizing mathematical models in natural science and engineering problems.

In an immense cycle of studies (completed in 1963) A.N. Tikhonov singled out a broad class of incorrectly formulated problems which he called regularizable. For the purpose of solving these problems A.N. Tikhonov introduced the concept of a regularizing algorithm and pointed out effective methods of constructing such an algorithm which can be easily implemented on a computer.

Under the guidance of Andrey Nikolayevich the method developed by him, which has been given the name "Tikhonov's regularization method," has been used for solving a great number of both fundamental general mathematics and timely applied problems.

The following problems in particular have been solved by the Tikhonov regularization method: the problem of finding a solution to an integral and operator equation of the first kind, inverse problems of the theory of potential and heat conduction, the problem of the analytic continuation of a function, the problem of restoring a function and its derivatives to a certain order from values of its Fourier coefficients perturbed in λ_2, incorrect problems of linear algebra, a number of problems in mathematical economics and the theory of optimum control, a number of important inverse problems in geophysics, astrophysics and optical and neutron spectroscopy, new problems in the theory of pattern recognition, and many others. The application of a modern system of mathematics for solving incorrect problems has made it possible to obtain a number of fundamental basically new results in these timely problems of natural science and engineering.

Under A.N. Tikhonov's leadership a fundamentally new approach has been developed to solving problems in the mathematical design of complicated physical systems, which, in particular, has made it possible to obtain constructive methods of creating real antenna systems for various purposes. The methods which have been developed have made it possible, while taking into account restrictions on sources for exciting the antenna and its structural parameters, to satisfy optimally the requirements for its radiation characteristics.

Of great importance to the development of modern natural science have been A.N. Tikhonov's studies relating to firm methods of solving inverse problems, to which, as a rule, is reduced the interpretation of many complex scientific experiments, and the development of the general principles for the creation of automated systems for the complete mathematical processing of complicated scientific experiments. A number of systems for automatically processing the results of physics experiments have been created under the direction and with the direct participation of Andrey Nikolayevich.

By means of these studies A.N. Tikhonov has created a new trend in mathematics and has developed a fundamentally new approach to problems relating to the automation of scientific research. Recently methods of solving incorrect problems have firmly entered the arsenal of modern mathematics and have been developed

successfully by numerous students and disciples of A.N. Tikhonov both here at home and abroad.

In concluding this review of the scientific achievements of Andrey Nikolayevich it is impossible not to stress the fact that he is an example of a scientist who for more than half a century now has obtained fundamental pioneering results in new areas of modern mathematics and its applications. A striking example of this is the recent work completed by Andrey Nikolayevich in 1980 and devoted to solving the classical problem of creating firm methods of solving linear algebraic equations with imprecisely assigned coefficients. Having established that an individual approximation system, even with in any manner great accuracy in representing it, contains insufficient information for obtaining an approximate solution to the original problem, A.N. Tikhonov has introduced into consideration the concept of a class of systems equivalent in accuracy to the individual system in question. This makes it possible to assume that the original problem is represented both by an approximate individual system and by a class of systems equivalent to it in accuracy. This new formulation of the problem makes it possible to suggest an original algorithm for effectively constructing a normal solution to poorly specified and degenerate systems of algebraic equations in the case of an approximately assigned operator.

A.N. Tikhonov is a brilliant teacher and the creator of a great scientific school representing many trends in modern mathematics and its applications. More than 50 doctors of sciences and a number or members of the USSR Academy of Sciences and republic academies are among his students. Andrey Nikolayevich's students throughout their entire life convey their gratitude to their wise and thoughtful teacher who has inculcated in them a basic attitude to science, and an aspiration to see the important, not only in proving new theorems, but also in applying mathematical methods to solving fundamental problems in natural science.

On his 75th birthday Andrey Nikolayevich Tikhonov is full of bubbling energy and creative ideas. From the heart we wish him good health and new outstanding achievements in his versatile activities.

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PUBLICATIONS

ABSTRACTS FROM JOURNAL 'FOREIGN RADIOELECTRONICS', AUGUST 1981

Moscow ZARUBEZHNAYA RADIOELEKTRONIKA in Russian No 8, Aug 81 pp 110-111

UDC 621.327.8:621.391.256

APPLICATION OF PACKET CODES IN COMMUNICATION SYSTEMS WITH PHASE MANIPULATION

[Abstract of survey by Banket, V. L., and Lyakhov, A. I.]

[Text] The authors examine questions about the matching of modems of a communication system with phase manipulation and codecs of packet codes. An estimate is made of the influence of error in the formation of coherent oscillation on the interference immunity of a system with phase manipulation and packet coding. An analysis is made of methods of applying packet codes in communication systems with relative phase manipulation and ways to eliminate phase ambiguity both by means of special devices and on the basis of properties of packet codes used to increase interference immunity.

UDC 519.95

SELECTION OF MILITARY COMPUTER ARCHITECTURE

[Abstract of survey by Vedeshenkov, V. A., Vlasenko, N. A., and Shevchenko, A. M.]

[Text] The authors examine a group of works devoted to the selection of the architecture of a family of military computers, done in 1975-1979 by a number of American organizations.

UDC 007.621:681.5.519:65.611.56

SELF-ADJUSTING CONTROL DEVICES

[Abstract of article by Koyvo, Kh. N., and Puzyrev, V. A.]

[Text] The authors examine problems in the control of technological processes in microelectronics by means of self-adjusting control devices. They discuss problems in the creation of algorithms of self-adjusting control devices, the realization of those algorithms by means of microprocessors, automation of the procedure in the creation of software for control microprocessor sets and their simulation on a universal computer.

UDC 534.232-8:534.8

CONTEMPORARY TRENDS IN THE DEVELOPMENT OF ACOUSTOELECTRONIC RADIO COMPONENTS

[Abstract of survey by Rechitskiy, V. I.]

[Text] The survey is devoted to methods of controlling the parameters and expanding the functional possibilities of acoustoelectronic radio components, in particular of band-pass filters on acoustic surface waves. The survey presents technical colutions contained in applications and patents of the leading countries of recent yeas and dealing with reduction of secondary acoustic effects determining the potential parameters of band-pass filters on acoustic surface waves.

UDC 621.373.826

STATE OF LASER GYROSCOPY ABROAD

[Abstract of survey by Savel'yev, A. M., and Solov'yeva, T. I.]

[Text] The operating principles, main errors and methods of increasing the precision of laser gyroscopy are described. The equipment and distinctive features of the design and technology of manufacture of laser gyroscopes of the leading foreign companies are examined.

UDC 626.396.676:629.78

SECOND-GENERATION SPACE ANTENNAS

[Abstract of survey by Glezerman, Ye. G., Klassen, V. I., Kolobov, V. A., Remizov, B. A., and Shishlov, A. V.]

[Text] The survey is devoted to the prospects of creating second-generation space antennas. The authors examine design, technological and electrodynamic problems of creating them, and also problems which can be solved in creating such antennas. Plans of NASA and the U.S. Department of Defense to create large-scale space structures and antennas are presented.

UDC 681.7.068/069

CIRCUIT ENGINEERING OF OPTICAL LINES OF COMMUNICATION WITH A CARRYING CAPACITY OF OVER 1 GBIT/S

[Abstract of article by Turinsky, Gunter]

[Text] Circuit engineering solutions of the receiving and transmitting parts of optical lines of communication with a carrying capacity of over 1 Gbit/s are described. Article translated from the German.

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TABLE OF CONTENTS FROM JOURNAL 'ELECTRONIC MODELLING', MARCH-APRIL 1981

Kiev ELEKTRONNOYE MODELIROVANIYE in Russian No 2, Mar-Apr 81 (signed to press 25 Feb 81) pp 1-2

[Table of contents from journal ELEKTRONNOYE MODELIROVANIYE]

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TABLE OF CONTENTS FROM JOURNAL 'ELECTRONIC MODELLING', MAY-JUNE 1981

Kiev ELEKTRONNOYE MODELIROVANIYE in Russian No 3, May-Jun 81 (signed to press 24 Apr 81) pp 1-2

[Table of contents from journal ELEKTRONNOYE MODELIROVANIYE]

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UDC 519.95

SUPERVISORY CONTROL OF MANIPULATOR ROBOTS

Moscow SUPERVIZORNOYE UPRAVLENIYE MANIPULYATSIONNYMI ROBOTAMI in Russian 1980 (signed to press 29 Aug 80) pp 4-12

[Annotation, table of contents and foreword from the book "Supervisory Control of Manipulator Robots", by Feliks Mikhaylovich Kulakov, Izdatel'stvo "Nauka", Glavnaya redaktsiya fiziko-matematicheskoy literatury, 3,600 copies, 448 pages]

[Text] The book is devoted to the problem of controlling manipulator robots--a new type of cybernetic device designed for automatic performance of a wide range of diverse operations usually performed by human hands. The principles of supervisory control, i.e., control exercised with the distribution of functions between man and computer directly connected to the robot when man utilizes only those functions which he performs better than the computer, are considered in it. Methods of designing the main functional systems--decision-making, communication and partially information and executive--and alsoproblems of crganizing computer processes are considered.

Contents

Foreword

One can follow over the course of centuries in the history of development of civilization how, due to improvement of labor tools, the most characteristic principle of this development was manifested. On the one hand, man achieved ever greater capabilities of limiting his participation in the production process and on the other hand the production process itself was gradually improved and complicated, which made it possible to develop objects of labor of unprecedented complexity, improvement and remarkable capabilities. The stone and club, the wheel, the lever, the loom, engines (steam, internal combustion and electrical), flying vehicles, radio, television, the atomic reactor, modern machine tools and finally the computer are some of the benchmarks of manifestation of this principle and benchmarks of scientific and technical progress.

Everything created up to now by man, except for the computer, expanded, intensified and improved his exceptionally physical capabilities and the real, qualitatively new capability of machine simulation of some aspects of human intellectual activity developed only with the appearance of electronic computers (EVM). A scientific trend that arose during the late 1960s and early 1970s and which has been named "artificial intelligence" is engaged in study of this capability.

The global purpose of investigations in the field of artificial intelligence is to find an answer to the question of how to program a computer so that processing the information entered in it will at least be similar in the final result to those which occur in the central nervous system of man when he makes decisions, draws conclusions and reprocesses the sensory information perceived by his senses.

It is difficult to overestimate the prospects which solution of this problem will open up since man will have at his disposal a wise, dispassionate and accurate advisor if he is successful. Even more intriguing and promising is to supply computers with actuating members (mechanical arms) and to embody its advice into "mental" actions of these members completely independent of man that are directed toward intelligent transformation of the real world. To realize these operations, a computer, by using special sensors, should be supplied with information about the real world and by using man-machine communication devices, should be supplied with information about the goals of operations. An automatic multipurpose system formed by the interacting combination of a specially programmed computer, mechanical arms, sensors and communication devices is also a system to which we connect the concept "manipulator robot."

Unlike other tools of labor developed by man until now, the robot is a tool of labor of completely new quality. The capability of self-contained, purposeful "intelligent" actions essentially creates the opportunity for these devices to reproduce themselves and places them in an exceptional position.

It is of course still too early to talk at present about realizing these capabilities of robots, but even those functional properties which they now have, based on today's state of science and technology, make development of these devices very timely. This is related to the fact that technical progress has very acutely posed the problem of replacing man with a robot in performing jobs in a situation threatening to human health (in space, the ocean and in aggressive media) and also simply low-intellect, monotonous jobs.

The first generation of manipulator robots is now being used extensively in industrial production where they replace people in performing stereotype auxiliary operations. These devices realize their functions successfully, true, only in a strictly organized external medium when the objects of their actions are in specific, previously known locations, which is typical for modern industrial production.

Of course, these types of robots are totally unsuitable to perform a wide range of jobs in a loosely organized variational environment. And this use of robots acquires ever more important significance and not only with regard to development of the ocean and space, where an acute need for these devices is now felt. The fact is that the real world is mainly a variational, indeterminate environment and expanding the areas of use of robots will inevitably be related to development of this world itself, which requires development of multifunctional robots adapted to diverse operations in it.

There are two methods of solving the posed problem. The first of them assumes development of an "intelligent" robot that fully performs any problems posed to it in a self-contained manner. The degree of intellect of this robot is determined by the possible range of problems toward which it is directed. This method provides a global, but extremely complex solution of the problem since we essentially do not yet have at our disposal either the hardware, theory or even the design ideas that permit one to count on development of robots in the near future that are similar in their capabilities to the intellectual capabilities of man.

The second method is more realistic. It assumes rejection of full autonomy of robot behavior and is oriented toward specific interaction of man and robot in performing the postulated task. In this case man utilizes only his own functions which he performs better than a computer, directly linked to a robot, could. This control is called supervisory control from the word "supervisor" (controller), the role of which man performs in the given case.

This method provides the capability of developing robots now with the required functional properties designed to work in a complex indeterminate environment. At the same time a convenient, practically viable capability of converting to design of an "intelligent," fully autonomous robot is established here by gradual transfer of robot control functions now performed by man to the computer, even up to complete freedom of man from control. It is obvious that development of such an "intelligent" robot will depend largely on the overall progress in the field of computer improvement and programming methods.

The known foreign literature devoted to consideration of this principle of robot control (perhaps with the exception of [19, 67, 104] and some others) is mainly descriptive in nature. At the same time it is recognized in it that prospects for expanding the areas of practical use of robots are related to supervisory control. This circumstance was also the thrust toward writing the book in which the author attempted to consider this question in as detailed a manner and as thoroughly as possible. The author's own developments which he conducted at the Leningrad Scientific Research Computer Center, USSR Academy of Sciences, comprised a significant part of the material.

The contents of the book can be divided into three unequal parts. The first of them, which includes Chapters 1-7, is devoted tc the principles of designing multilevel systems for control of the guided actions of the manipulator robot (decision-making systems), by means of which the plan of robot behavior is autonomously formulated on the basis of the goal posed to him by the human operator and with regard to information about the characteristics of the real world delivered by the robot sensors. Main attention is devoted to the principle of designing a decision-making system based on methods of the classical theory of automatic control. This is related to the fact that this principle perhaps corresponds to the greatest extent to the capabilities of practical robot control at the given phase of development of supervisory control.

Problems of designing the typical functional robot system with supervisory control --a communication system by means of which man and robot interact, are considered in the second part (Chapter 8). The apparatus and communication languages, including the YaRS input language developed by the author, are described in it.

The third part (Chapters 9 and 10) is devoted to problems of organizing calculating processes with supervisory control of the robot, which includes interaction of numerous robot software modules during functioning of the decision-making system, entry of information from the robot sensors and also entry of instructional information from the human operator.

The material of the book comprises the basis for a course of lectures "Robot Control Theory," which the author read at the Faculty of Applied Mathematics--Control Processes, Leningrad State University. With regard to this experience, the author made more specific the consideration of a considerable number of questions by introducing relevant examples, hoping that engineers who usually prefer this type of exposition would be interested in the book.

In conclusion, the author feels it his pleasant duty to thank his colleagues V. A. Lachinov, S. I. Novachenko, V. A. Pavlov and A. A. Kuz'min for active assistance in working on the book.

He is also grateful to F. S. Petrov whose critical comments and advice and also direct work on the manuscript helped to significantly improve the style of outlining the material.

V. M. Ponomarev, D. Ye. Okhotsimskiy and Ye. P. Popov played a special role in the history of the book. The book would probably not have come to light without their moral support, valuable advice and sincere interest.

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LIST OF ARTICLES ON COMPUTER TECHNOLOGY, JANUARY-FEBRUARY 1981

Moscow PRIBORY, SREDSTVA AVTOMATIZATSII I SISTEMY UPRAVLENIYA, TS-2: SREDSTVA VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI (BIBLIOGRAFICHESKIY UKAZATEL' NEOPUBLIKOVANNYKH I VEDOMSTVENNYKH MATERIALOV) in Russian No 1, Jan-Feb 81 pp 1-17

[List of bibliographic items from SREDSTVA VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI (COMPUTER HARDWARE AND OFFICE EQUIPMENT), a bibliographic publication of TsNIITEIpriborostroyeniya]

[Excerpts]

UDC 681.324

1. Investigation of questions regarding increase of the productivity of a hierarchic computer complex. Shyaudkulis, V. I. In book: "Izmeritel'no-vychislitel'nyye kompleksy i sistemy avtomatizatsiya nauchnogo eksperimenta" (Measurement-computational Sets, Systems for Automation of Scientific Experiment). Moscow, 1979, No 73, pp 84-91 (Trudy INEUM--Proceedings of the Institute of Electronic Control Machines). Bibliography: p 91 (3 items). GPNTB. (USSR State Public Scientific-Technical Library).

UDC 628.84:681.3

8. "Uluchsheniye sistemy konditsionirovaniya vozdukha v zale EVM 'Minsk-32'" ("Improvement of the air conditioning system in a 'Minsk-32' computer room. Gor'kiy, 1980, 4 pages. Gor'kiy TsNTI (Center of Scientific-Technical Information and Propaganda) Information Sheet No 231-80. GPNTB.

UDC 681.3.001.2

16. Algorithmic methods for semi-automated technical planning system for YeS computers (PASP-ESAP). Vetchinin, M. P., Ginzburg, B. D., and Dolin, G. M. "Voprosy radioelektroniki. Seriya EVT" ("Questions of Radioelectronics. Computer Hardware Series"). Scientific-Technical Collection, 1980, No 1, pp 12-20. Bibliography: p 20 (7 items).

20. Basic software of the M-400 computer and "Elektronika-100/16 I" for coupling them with the BESM-6. Shirovskaya, L. A., and Shishkin, V. I. "Elektronnaya tekhnika. Seriya 1. Elektronika SVCh" ("Electronic Technology. Series 1. Ultra-high Frequency Electronics"). Scientific-Technical Collection. TsNII (Central Scientific Institute) "Elektronika," 1979, No 12, pp 77-78. Bibliography: p 78 (4 items).

UDC 681.3.06:681.3.015

21. Basic software for construction of interaction packages of programs in YeS computer operating systems. Gleym, V. V., Zgonnik, O. N., Ivanyutin, A. I., et al.

UDC 681.3.06

In book: "Dialogovyye sistemy. Vyp 3. Realizatsiya dialogovykh sistem" (Interactive Systems. No 3. Realization of Interactive Systems). LatvSSR Academy of Sciences, Institute of Electronics and Computer Technology. Riga, 1980, pp 3-16. Bibliography: pp 15-16 (8 items). GPNTB.

UDC 539.382

23. "Bol'shoy modul'" ("Large module"). Moscow, 1980, 2 p. VIMI Information Sheet No 80-1050. Series ILT9-12-24-02. GPNTB.

UDC 681.3.06:681.327

31. Investigation of characteristics of a package of applied programs of the "SNOD" data bank for the M-4030 process control computer complex. Marusevich, A. A., and Karetnikova, L. N. In book: Izmeritel'no-vychislitel'nyye kompleksy i sistemy avtomatizatsii nauchnogo eksperimenta. Moscow, 1979, No 73, pp 95-101. (Trudy INEUM). GPNTB.

UDC 681.3.06

32. Expansion of the COBOL language for the "Minsk-32" computer. Osipyan, V. S., and Miroshnichenko, V. V. In book: Materialy nauchno-prakticheskoy konferentsii po problemam ASU (Materials of the Scientific and Practical Conference on ASU Problems). TadzhSSR Academy of Sciences, NIIEMMP with the TadzhSSR Gosplan Computer Center. "Znaniye" Society, Dushanbe, 1980, pp 60-64. GPNTB.

UDC 681.3.01:621.398

35. "Matematicheskoye obespecheniye sistemy teleobrabotki dannykh YESTEL-2" ("Software of the YESTEL-2 remote data processing system"). Ufa, 1980, 4 p. Bashkir TsNTI Information Sheet No 226.80.

UDC 519.85

38. On a rational programming technology. Gavrilov, G. K. "Voprosy radioelektroniki. Ser EVT." Scientific-Technical Collection, 1980, No 8, pp 135-141. Bibliography: p 141 (8 items).

UDC 681.3.06

40. One variant of a pre-processor of reduced Russian language for systems of automated solution of problems. Vasilev, M. V., Gritsanenko, A. V., Groys, B. Ye., et al. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 1, pp 44-49. Bibliography: p 49 (11 items).

UDC 681.3.068

44. Package of applied program RESURSY and its possibilities in solving tasks in the control of large NIOKR. Roytman, A. I., and Kulikova, L. G. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 1, pp 113-120. Bibliography: pp 119-120 (2 items).

UDC 681.3.06

52. Programs "Svyaz' 1" and "Svyaz' 2" for information exchange between the BESM-6 and "Elektronika-100I" computers. Zakharova, A. N., and Ovchinikova, L. S. "Elektronnaya tekhnika. Seriya 1. Elektronika SVCh." Scientific-Technical Collection. TsNII "Elektronika", 1979, No 12, 76 pages. Bibliography: p 76 (3 items).

54. "Sistema psevdokomand dlya obrabotki 24-razryadnykh slov (SOS-24) dlya EVM tipa 'Saratov'" ("Pseudocommand system for processing 24-bit words (SOS-24) for 'Saratov' computers"). Greibek, M. G., and Presler, V. T. Tomsk, 1979, 31 p with ill. Tomsk Polytechnic Institute Imeni S. M. Kirov, Deposited Manuscript No 1211. Examines program simulation of pseudocommands for processing double-length words on the example of the SOS-24 system of pseudocommands for the Saratov computer.

UDC 681.3.06

58. User's language to describe data preparation on a carrier. Konoval'chuk, V. N. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 1, pp 30-43. Bibliography: p 43 (4 items).

UDC 681.3

59. Some results of the international exhibition "YeS and SM computer facilities and their application." Kaminskiy, S. M., and Stelboval, Ye. A. "Voprosy radioelektroniki. Seriya ASU." Scientific-Technical Collection, 1980, No 1, pp 3-12 with ill.

UDC 681.324

60. Organization of the reception and accumulation of experimental information in a multimachine system based on the M-4030 modular system of computer technology. Klopov, N. V. and Novodvorskiy, Ye. G. In book: "Materialy nauchno-prakticheskoy konferentsii po problemam ASU" ("Materials of Scientific-Practical Conference on ASU Problems"). Tadzhik SSR Academy of Sciences, NIIEMMP with the Tadzhik SSR Gosplan Computer Center. "Znaniye" Society, Dushanbe, 1980, 11 p, GPNTB.

UDC 681.3:658.589.011.46

61. "Povysheniye effektivnosti raboty EVM 'Nairi'" ("Increasing the efficiency of the 'Nairi' computer'). Adlivankin, A. Yu., Maryukhnenko, N. P., Iozef, A. G., et al. Khar'kov, 1980, 7 p with ill. State Scientific Research and Planning Institute of Basic Chemistry. Deposited Manuscript No 1252. Measures are proposed to increase the efficiency of the 'Nairi' computer by using interchangeable cassettes of long-term memories with master programs built in them, which protects the machine against the influence of failures and expands the possibilities of an efficient memory.

UDC 681.3

66. Elementary base of the YeS-1060 computer and distinctive features of its application. Samorukov, V. V. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 8, pp 72-83. Bibliography: p 83 (2 items).

UDC 681.327.12

67. "Adapter fotoschityvayushchego ustroystva FS1501" ("FS1501 photo-reading device adapter") Moscow, 1980, 2 p. VIMI Information Sheet No 80-0076. Series ILVT-13-08-05. GPNTB.

UDC 681.327.12

70. Methods of automatic reading of information from standardized forms. Ivanov, Yu. F. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 1, pp 66-75. Bibliography: p 75 (2 items).

UDC 681.327.12

72. "Ustroystvo dlya vvoda graficheskoy informatsii v EVM 'Grafika-02'" ("Graphic information input device for 'Grafika-02' computer"). Novosibirsk, 1980, 3 p with ill. Novosibirsk TsNTI Information Sheet No 6-80. Intended for semi-automatic coding and input into the computer of graphic-drawing information on a dielectric carrier, and the formation of codes of special graphic symbols.

UDC 681.325.5-181.4

78. Analysis of the loading of uniform microprocessor shared multicomputer systems. Makarevich, O. B., Saak, E. M., and Cherranov, A. G. In book: "Avtomatika i vychislitel'naya tekhnika" ("Automation and Computer Technology"). LatvSSR Academy of Sciences, Institute of Electronics and Computer Technology. Riga, 1980, No 4, pp 32-36. Bibliography: p 36 (3 items).

UDC 681.327.634

79. Analysis of time characteristics of the interaction of main and external magnetic disk storages. Smirnov, S. N. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 8, pp 21-31. Bibliography: p 31 (6 items).

UDC 681.327.634

80. Interchangeability of plug-in magnetic disk stores and some features of their use. Aleshinskiy, M. P., Kostyuchenko, Yu. G., and Kudagin, V. G. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, pp 76-80 with ill.

UDC 681.327.636

82. From experience in use of YeS computer magnetic tape stores. Zamorin, V. P., Kuzyutin, V. V., and Kulagin, V. G. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 1, pp 153-161 with ill. Bibliography: p 161 (2 items).

UDC 681.327.63

83. Provision of reliable data storage and reading of magnetic carriers. Buglayeva, L. D., Krylov, G. M., and Lubovinina. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 1, pp 81-89.

UDC 681.327.634

85. Structure and working principles of YeS-5566 control device for YeS-5066 plug-in magnetic disk stores with a capacity of 100 Mbytes. Novikov, V. A., and Sushenko, K. V. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 1, pp 143-152. Bibliography: pp151-152 (5 items).

UDC 681.3.067

86. Structure of control of the virtual memory and operating system of YeS computers. Lebed', M. Ya. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 1, pp 90-100 with ill. Bibliography: p 100 (2 items).

UDC 681.3.01

89. Realization of a subsystem of information exchange of a center of message commutation with subscriber points. Koznitsev, A. V. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 8, pp 16-20. Bibliography: p 20 (4 items).

UDC 681.586:681.3

91. Random number generators for YeS computers. Vitaliyev, G. V., Zhukov, A. V., and Chugukov, A. P. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 1, pp 101-112. Bibliography: p 112 (6 items).

UDC 681.3-181.48

105. Application of mini-computers to automate decision making. Syasin, A. V., and Kuznetsov, I. V. "Voprosy radioelektroniki. Seriya ASU." Scientific-Technical Collection, 1980, No 1, pp 21-25. Bibliography: p 25 (3 items).

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CSO: 1863/259

LIST OF ARTICLES ON COMPUTER TECHNOLOGY, MARCH-APRIL 1981

Moscow PRIBORY, SREDSTVA AVTOMATIZATSII I SISTEMY UPRAVLENIYA, TS-2: SREDSTVA VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI (BIBLIOGRAFICHESKIY UKAZATEL' NEOPUBLIKOVANNYKH I VEDOMSTVENNYKH MATERIALOV) in Russian No 2, Mar-Apr 81 pp 1-15

[List of items from SREDSTVA VYCHISLITEL'NOY TEKHNIKI I ORGTEKHNIKI (COMPUTER HARDWARE AND OFFICE EQUIPMENT), a bibliographic publication of TsNIITEIpriborostroyeniya]

[Excerpts]

A. COMPUTER TECHNOLOGY

A.1. General Questions of Computer Technology

116. "Vychislitel'naya tekhnika v 80-e g.g." ("Computer Technology in the 1980s"). Moscow, 1980, 18 p. TsNIITEIpriborostroyeniya Operational Bulletin No 47.

UDC 658.012.011.56:658.56

117. Quality and efficiency of processes of delivery, generation, introduction into operation and maintenance of basic software in the system of complex centralized servicing of YeS computers. Pyatibratov, A. P. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 6, pp 3-7.

UDC 681.518

118. Application of numeration theory in information system planning. Lin'kov, V. M., and Khot'ko, S. M. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 6, pp 112-119. Bibliography: p 119, (3 items).

UDC 614.843/.847:681.3

119. Fireproofing standards in planning buildings and rooms for computers. Mishin, V. F., and Gavrilov, A. M. Avtomatizatsiya i kontrol'no izmeritel'nyye pribory v neftepererabatyvayushchey i neftekhimicheskoy promyshlennosti (Automation and Instrumentation in the Oil Refining and Petrochemical Industries). Scientific-Technical Abstract Collection. TsNIITEneftekhim (Central Scientific Research Institute of Information and Technico-economic Investiagions of the Oil Refining and Petrochemical Industries), 1980, No 5, pp 22-23.

UDC 681.3

120. "Sozdaniye i primeneniye sredstv vychislitel'noy tekhniki na firme NEC" (Creation and use of computer hardware at the NEC Company"). Moscow, 1980, 5 p. TsNIITEIpriborostroyeniya Operational Bulletin No 53.

UDC 681.5.01

121. Control of complex organizational-technological systems on the basis of simulation. Gorskiy, L. K., and Golev, V. P. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 6, pp 8-19. Bibliography: p 19 (2 items).

A.2. Theoretical Questions

UDC 681.324

122. Selection of optimal criteria for checking the working capacity of computer systems. Golub, V. B., Zhukov, G. V., Lyubatov, Yu. V., et al. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 5, pp 92-100. Bibliography: p 100 (3 items).

UDC 621.382.233.011.222.072.1

123. Machine simulation of a transistorized shift register with plasma connection. Vekshina, Ye. V., Skorik, V. A., and Fursin, G. I. "Elektronnaya tekhnika. Seriya 3. Mikroelektronika" ("Electronic Technology. Series 3. Microelectronics"). Scientific-Technical Collection. TsNII "Elektronika", 1980, No 2, pp 63-66 with ill. Bibliography: p 66 (5 items).

UDC 681.3.013.2

124. The problem of the disposition of simulation circuits during multiprogram data processing on an analog computer. Varyukha, A. M., and Smol'yaninov, A. A. In book: "Novyye elementy i metody rascheta informatsionnykh sistem" ("New Elements and Methods of Information System Calculation"). Intervuz Collection of Scientific Works. Moscow Institute of Radio Engineering, Electronics and Automation. Moscow, 1979, pp 199-204. GPNTB.

UDC 681.325.65

125. The collection of statistical data during simulation of circuits on the logical-functional level. Vitenberg, I. M., and Itina, L. S. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 4, pp 68-81. Bibliography: p 81 (3 items).

UDC 681.3-192

126. Optimization of computer structure synthesis and diagnosis. Rodzin, S. I. IZVESTIYA SEVERO-KAVKAZSKOGO NAUCHNOGO TSENTRA VYSSHEY SHKOLY. TEKHNICHESKIYE NAUKI, 1980, No 1, pp 45-48. Bibliography: p 48 (3 items).

UDC 681.324

127. Principle of modular construction of simulation models of computer control complexes. Kuz'min, A. V., and Lukashchuk, L. A. In book "Kontrol'no-izmeritel'naya tekhnika" ("Instrumentation"). Republic Interdepartmental Scientific-Technical Collection. L'vov Polytechnic Institute, L'vov, 1980, No 27, pp 68-71. GPNTB.

See also No 157

A.3. Reliability of Computers

UDC 681.325.65

128. "Avtomat dlya proverki logicheskikh yacheyek" ("Automatic machine for testing logical cells"). Moscow, 1980, 2 p with ill. VIMI Information Sheet No 80-0204. Series ILKIA 13-05-08.

129. "Avtomatizirovannaya sistema kontrolya logicheskikh blokov" ("Automated system for monitoring logical blocks"). Moscow, 1980, 3 p with ill. VIMI Information Sheet No 80-0125. Series IIKIA 13-05-08. GPNTB.

UDC 681.3.06

130. "Dorabotka skhemy kontrolya registra mikrokomandy" ("Completion of a circuit for monitoring a microcommand register"). Tula, 1980, 3 p. Tula TsNTI Information Sheet No 433-80. Intended to reduce time spent on searching for defects in the permanent memory of the YeS-2420. GPNTB.

UDC 681.3-192

131. Organization of subsystems assuring reliability of computer hardware in a system of complex centralized servicing. Kobrakov, M. Ye. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 6, pp 72-76. Bibliography: p 76 (3 items).

UDC 621.325.5-181.4:621.3.049.771.14

132. The "Elekon SF" system for monitoring electrical parameters of large-scale integrated microcircuit stores and microprocessors. Grachev, O. G., Danilin, N. N., Lukhovskiy, L. V., et al. "Elektronnaya promyshlennost'" ("Electronic Industry"). Scientific-Technical Collection. TsNII "Elektronika," 1980, No 6, pp 21-31 with ill.

UDC 620.1.05:681.5132

133. "Stend dlya ispytaniya sistemy chislovogo programmnogo upravleniya 'Razmer 2M-1104' UCh" ("Test stand for the 'Razmer 2M-1104' frequency analyzer for a numerical program control system"). Rostov-na-Donu, 1980, 4 p. Rostov-na-Donu TsNTI Information Sheet No 552-80. GPNTB.

UDC 621.3.084.87

134. "Ustroystvo dlya proverki blokov upravleniya pitaniyem BUP-32 i BUP-UA" ("Device for testing BUP-32 and BUP-UA power control units"). Minsk, 1980, 5 p. BelNIINTI Information Sheet No 193. Series 13-08. GPNTB.

135. Physical diagnosis of the reasons for failures and its application to analysis of the structure of computer failure flow. Verigin, V. V., Antontseva, T. L., Makhrov, V. F., et al. "Voprosy radioelektroniki. Seriya EVT." Scientific-Technical Collection, 1980, No 5, pp 21-30. Bibliography: p 30 (5 items).

See also Nos 122, 172, 177 and 189

A.4. Software

UDC 681.3.064

136. Automation of the development of input programs and data monitoring. Rybakov, A. V. "Elektronnaya tekhnika. Seriya 9. Ekonomika i sistemy upravleniya" ("Electronic Technology. Series 9. Economics and Control Systems"). Scientific-Technical Collection. TsNII "Elektronika", 1980, No 4, pp 16-18. Bibliography: p 19 (3 items).

137. "Avtomatizirovannaya podgotovka upravlyayushchikh programm dlya stankov s ChPU" ("Automated preparation of manager programs for machine tools with numerical control. Moscow, 1980, 2 p. GOSINTI (State Scientific Research Institute of Scientific and Technical Information) Information Sheet No 239-80. GPNTB.

UDC 681.3-181.48:681.327

138. "Avtomatizirovannyy bank dannykh dlya upravleniya linii-EVM M-6000" ("Automated data bank for control of the M-6000 line computer"). Khar'kov, 1980, 4 p. Khar'kov TsNTI Information Sheet No 220-80. Series 1. "ASU, Computer Hardware and Organizational Technology." GPNTB.

UDC 681.3.06

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UDC 681.3.015

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UDC 621.9.06-529

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A.5. Computers

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UDC 681.325.65

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UDC 681.51

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UDC 681.327.6:681.325.65

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UDC 550.8:681.3

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UDC 681.3.06

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